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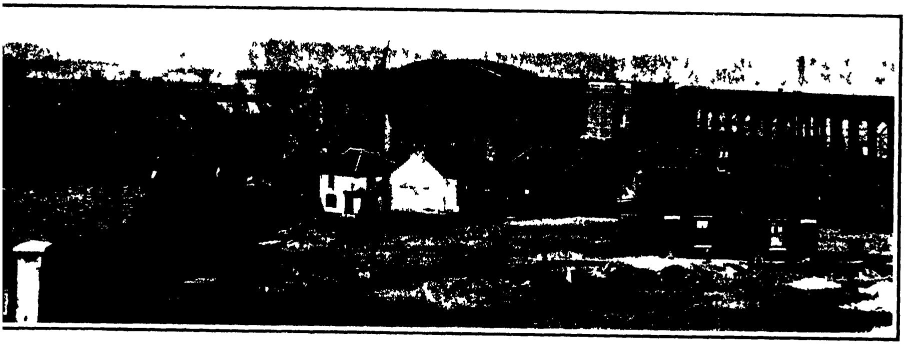
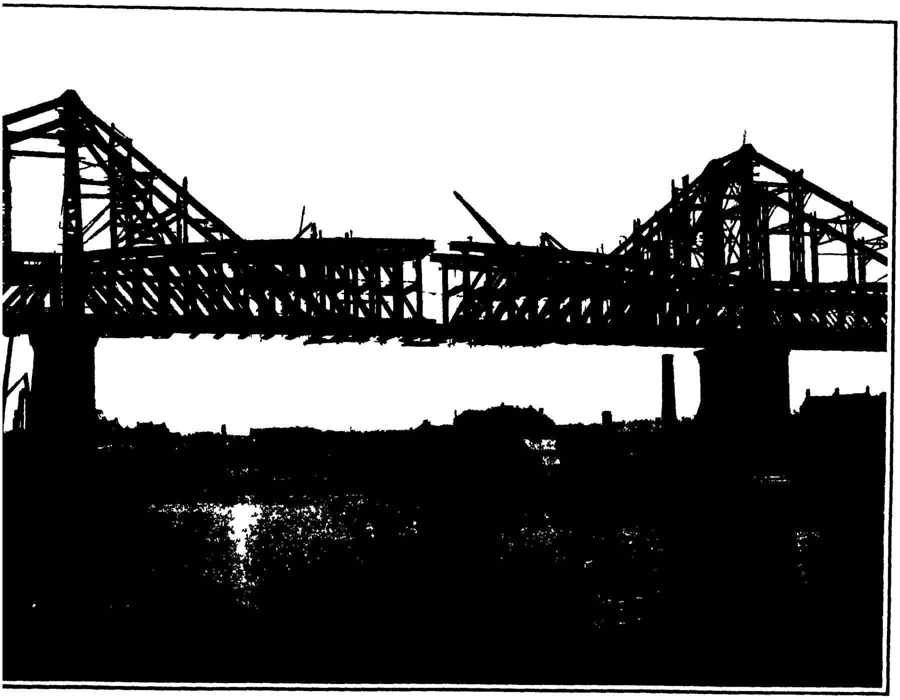


THE DOUBLE-DECK BRIDGE [illegible]



CONNECTING UP THE CENTRAL SPAN OF THE WEAR OVER B[illegible]

THE DOUBLE-DECK BRIDGE OVER THE WEAR

THE DOUBLE-DECK BRIDGE OVER THE WEAR.

A COMBINED RAILWAY AND HIGHWAY BRIDGE.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A LARGE double-deck bridge has been constructed over the River Wear England to accommodate both railroad and highroad traffic The town of Sunderland numbering some 1 0 000 people is fairly evenly divided between the two banks of the river For several years the necessity of improved communication between the opposite banks has been felt At last the various surrounding local bodies the town of Sunderland and the North Eastern Railroad decided to combine in the erection of a large bridge suited to all classes of traffic The outcome was the erection of the massive bridge shown in the accompanying illustrations The lower deck is restricted for pedestrian and vehicular traffic and is practically the property of the Sunderland municipal authorities while the upper deck carries the railroad track and is the property of the railroad

The erection of a bridge at the point desired was no easy matter The shipping traffic on the waterway demanded that ample headway should be provided for vessels and that the construction should be so carried out as not to interfere with the launches from the shipbuilding yards on either side The designing of the structure and the whole of the subsidiary work in connection therewith were carried out by Mr Charles A Harrison D S the chief engineer to the North Eastern Railroad His design comprised a bridge 1 220 feet in length between abutments composed of three shore spans each of [illegible]00 feet and a main river span 330 feet long and 85 feet above high water In addition there was much very heavy approach work since the railroad to gain the bridge has to be carried at a high level The lower deck has an overall width of 64 feet there being a projection of some 11½ feet on either side of the main girder carrying a foot sidewalk and a foot space for gas and water mains the transoms being cantilevered out on each side for this purpose The clear width of the roadway within the bridge is 26 feet with a clear height between the surface of the road and the under side of the railroad deck of about 14 feet On the shore spans the girders are 30 feet in height throughout while in the case of the river spans the ends are 0 feet in height curving to 4[illegible] feet in height at the center The railroad deck carries a double track

The contract was secured by Sir William Arrol & Co Ltd the builders of the Forth Bridge to whose courtesy we are indebted for the accompanying illustrations Constructional work was commenced early in 1905 The piers are built of granite those for the river span being 48 feet wide above the plinth by 25 feet in thickness They are built in two rectangular shafts 16 feet in width connected at the top by an arch On the south side the pier is carried on a steel caisson measuring 63 feet in length by 35 feet wide and 41 feet deep and sunk to a depth of 75 feet below high water mark by superimposed weight the material within being excavated under compressed air The work was so carried out that the top level of the masonry superstructure was kept just above high water mark so that the necessity of a cofferdam was avoided The height of the pier from foundation to coping level is 170 feet The pier on the north bank rests upon a concrete foundation which was laid within a timber cofferdam

The erection of the shore spans was carried out rapidly and uneventfully and it was in connection with the main river span that the greatest difficulty arose The traffic on the waterway precluded the possibility of carrying out this section other than upon the overhang system the girders being carried out member by member from either side and finally connected up in the center

The method by which this was accomplished is clearly shown in the accompanying illustrations The main bearings of the river span were first set in position and the first pieces of the lower booms laid The end vertical members were placed in position When their correct position and other adjustments were effected packing steel blocks were inserted between the main girders of the shore and river spans in such a manner as to secure an even distribution of the strains The upper booms were temporarily connected to the shore span When the adjustments had been completed the diagonal members of the bay were erected as well as the flooring to secure lateral stiffness Temporary steel towers were then erected on each pier above the end members of the spans and anchored to the shore span as illustrated these towers being 70 feet in height As the overhanging section proceeded outward the weight was supported by means of ties This was the procedure successfully adopted in the erection of the Forth Bridge The greatest load to which any one set of supporting ties attached to one girder was subjected amounted to 710 tons Successive bays were erected in this manner until the two overhanging sections had approached each other to within 8 feet

The top and bottom booms of each girder are 4½ feet wide by 3½ feet deep and the lattice framework wind bracings are spaced 24 feet apart between the top booms about 3¾ feet deep The girders are divided into panels by vertical members spaced 12 feet apart The total weight of a single girder in the river span is 960 tons and altogether about 8 500 tons of steel work have been worked into the whole structure

In the official tests prior to the opening of the bridge under a load of twelve locomotives representing nearly 1 200 tons the river span showed a deflection of about 1 inch The lower deck will carry a street railroad track for the electric cars of the Sunderland Corporation which contributed $7 0 000 toward the scheme as well as the provision of a considerable extent of necessary land while the total cost of the bridge was approximately $2 250 000 In addition to the bridge itself there are nearly two miles of approach for the railroad to gain the high level

A LOG BOX AND HOW TO MAKE IT.

SUGGESTIONS FOR THE AMATEUR MECHANIC.

A LOG BOX unlike a coal box is not necessarily a piece of furniture for the dining or drawing room To suit the purpose it is intended for it is bound to be roomy or it would be useless so that a log box pure and simple is no ornament to a room The idea we have in view is to combine the advantages of a log box with those of a hall stool or seat and this we show in Figs 1 and 2 It should if possible be made of oak or failing that American whitewood can be stained oak color and makes a very good substitute There is nothing intricate in the construction It wants to be strong of course and no joints should be obtrusive In order to accomplish this end the front and back are let into grooves

Fig 3 shows one of the sides The height is 2 feet 3 inches width at bottom 15 inches and at top 12 inches made out of ¾ inch wood or not less than ⅝ inch Fig 4 shows the front (or back piece as they are both alike) with the ends cut in the form of a shoulder or rebate to let into the grooves in the sides It measures 18 inches square not including the rebates The grooves for the bottom of the box come 3 inches from the floor line and instead of cutting a shoulder in the bottom board bevel the edges down on both sides to fit If ¾ inch wood is used the grooves should be ½ inch wide and nearly ½ inch deep and if thinner wood is used they must be proportionately less The width necessitates a joint in each part A glued joint is strong enough provided the edges to be joined are shot quite true not too much glue used and that well rubbed out by working the two boards together then securely clamping until quite set The hollows at the bottom are cut out with a frame saw and the heart shape holes with a keyhole saw having first prepared an opening with a twist bit

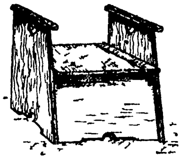


FIG 1 - GENERAL VIEW

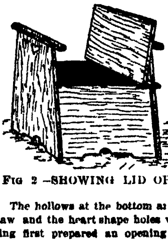


FIG 2 - SHOWING LID OPEN

To put the parts together lay one side on the floor face downward glue in the front and back, slide the bottom in (gluing it also) and then fix the other side on seeing that there is no twist in the box before the glue sets and finally binding it tightly round with strong cord

When set fix a 2-inch malleable iron bracket (one that has no stay) to each corner inside and underneath the bottom glue several small blocks of wood

The seat is 15 inches wide, with the grain of the wood running at right angles to the front, the flap or lid is 15 inches long and the fixed part 3 inches the lid being hung with a pair of 2-inch brass butt hinges

To fix the 3 inch part of the seat drill a ⅝ inch hole with a twist bit through it into the front and back of the box then fit and glue in wooden pegs of the same material and also glue two or three small wood blocks underneath to the side of the box. The arm rests or caps for the sides are 14 inches long and 1½ inches wide grooved underneath and glued on

If the box is made of oak as a finish rub in some raw linseed oil and repeat the process two or three times until the oil is well rubbed in but if made of whitewood get some oak water stain (not varnish stain) and apply it with a piece of sponge allowing one coat to dry well before putting on a second the number of applications depending upon the shade required then rub in the oil as directed above and the result will be infinitely better than varnish —The Woodworker

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The Telephone Engineer, in a recent issue describes a relay that has been devised for use with the telephone receivers of wireless telegraph systems It consists of a step down transformer the secondary of which is connected to an electrolytic detector while the primary is connected to a telephone receiver The former has a resistance of 450 ohms and the latter a resistance of 3 ohms One end of a carbon rod rests on the diaphragm of the telephone receiver, while the opposite end engages a carbon block, thus forming a microphone The second telephone is placed in circuit with this microphone and a battery, and thus reproduces the "wireless" signals so loudly that they can be heard throughout a large room.

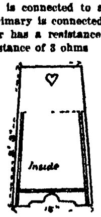

FIG 3 —VIEW OF END

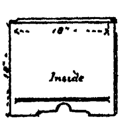

FIG 4 FRONT OR BACK

THE HORSE-POWER OF A WATERFALL.*

HOW TO DETERMINE THE VALUE OF A WATER POWER.

BY W. T. RYAN.

Up to a few years ago water powers were usually bought for a 'song and water wheels were installed as the business increased without first ascertaining the actual horse power of the stream Now however the available power has increased in value to a point where both owners and users find it desirable to determine beforehand as nearly as possible how much power there is available

It is the purpose of this article to point out the principal things the owner or purchaser should know and to present simple methods for making an estimate of the available power

The first thing to be done is to determine the specific conditions which nature has established the principal items being average maximum and minimum rainfall drainage area run off evaporation absorption available head flood and minimum discharge of the stream

There are two factors which enter directly into the determination of a water power the quantity of water flowing down a stream per unit of time and the fall or head available The fall or head should be determined by a competent surveyor This head is usually limited by the cost of the overflowed lands It is advisable to accompany the surveyor when he runs his levels in order to see that no little drainage ditches or natural outlets are overlooked which might be draining many acres of valuable land and which would be rendered useless when the water is backed up by the dam A county map is a great aid in getting the acreage of the submerged lands

The next quantity to be determined is the quantity of water flowing in the stream per unit of time It is usual practice to get this in terms of pounds per minute This determination is extremely important and to be accurate the measurements should extend over a period of several years This usually being impossible the best that can be done will be to take measurements at periods of low water If the observer is a stranger in the community good information as to these periods of low water may be obtained from some of the old fishermen or hunters It is not advisable to depend on the merchants or bankers for this information If the stream is large enough a government report may be had by applying to the United States Geological Survey These reports are very valuable in making an estimate of the annual power but care should be taken in using the reports on maximum flood flow as in some instances they are unreliable

The quantity of water flowing in a stream may be fairly well estimated as follows The velocity of water is obtained by means of a float In this method of measurement the velocity is obtained by observing the time it takes a light floating body such as a ball or piece of wood so colored and weighted as to be readily seen to pass over a known distance The surface velocity is then

$$v = l \div t$$

where l is the distance described between parallel transverse alinements whose distance apart is known and t = the time taken The velocity is a maximum just below the surface and diminishes from that point both toward the bottom and toward the surface It is also a maximum near the middle of the stream diminishing toward the banks The mean velocity is about 83 per cent of the maximum surface velocity when the air is still

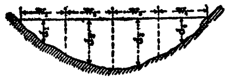

Fig 1

Therefore

$$Q = 0\ 83\,A\,v \qquad (1)$$

where

Q = discharge in cubic feet per second,

A = area of transverse section of the stream in square feet,

v = maximum surface velocity in feet per minute when the air is still

Of eight experiments cited by Prof Bowser only one gives a value (= 0 62) differing more than 0 05 from 0 83, while others obtained the values 0 82 0 78 0 82 0 86, 0,82, 0 83

The horse-power available is obtained from the formula

$$H\ P = \frac{(Q)\,(h)\,(62\ 5)}{33\ 000} \qquad (2)$$

where h = the fall or head in feet

An improvement over the foregoing is to divide the stream into a number of subdivisions (Fig 1) in widths w w_1 w_2 etc and mean depths of d d_1 d_2 etc and with respective maximum surface velocities of v v_1 v_2 etc which may be determined either with a float or with current meters whence we may write

$$Q = 0\ 83\,(w\,d\,v + w_1\,d_1\,v_1 + w_2\,d_2\,v_2 + \ldots) \qquad (3)$$

The use of double floats (Fig 2) is preferred by many engineers Two balls of the same bulk and condition of surface one lighter the other heavier than water are united by a slender chain their weights being so adjusted that the light ball without projecting above the surface buoys the other ball at some predetermined depth By placing several double floats across a stream and noting their velocity the average velocity may be quite accurately determined

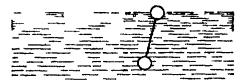

Fig 2

If a very accurate determination of the velocity is desired a reliable current meter should be employed There are three general methods for getting the velocity with a current meter the single point method the multiple point method and the integration method In the single point method the current meter is held at the depth of mean velocity which is about 0 6 of the distance from the surface to the bottom This method is used a great deal and is sometimes called the six tenths depth method In what is known as the single point subsurface method the current meter is held near the surface or just low enough not to be affected by the wind This method is used when the meter cannot be submerged to 0 6 of the depth on account of the swiftness of the stream

The multiple point method may be subdivided into (1) the vertical velocity curve (2) surface and bottom and (3) surface mid depth and bottom The vertical velocity curve method consists of taking velocities at several depths equal intervals apart and taking the mean velocity of the stream at the average of these values The surface and bottom method is sometimes used for shallow streams with comparatively smooth beds The current meter is held about six inches below the surface and about six inches above the bottom and the mean of the two velocities is taken as the average velocity of the stream In the top mid depth and bottom method the current meter is held six inches below the surface at mid depth and six inches above the bottom The mean velocity is obtained by dividing the sum of the top velocity twice the mid depth velocity and the bottom velocity by four In the integration method the meter is lowered to the bottom at a slow uniform speed then back again to the surface The total number of revolutions divided by the time gives the mean velocity It is well adapted for measurements under ice and as a check on the point methods

In small streams the quantity of water may be measured by means of a weir From extensive experiments at Lowell Mass with rectangular overfall weirs, J B Francis deduced the following formula

$$Q = 3\ 33\,(L - 0\ 1\,n\,H)\,H$$

where

Q = discharge in cubic feet per second

l = length of weir in feet

H = distance in feet from sill of notch to level surface of water a few feet back

n = number of contractions

In general

n = 2 when no edge is flush with the sides or bottom of a channel (Fig 3)

n = 1 when one end only is flush with the side of the channel

n = 0 when both sides are flush with the sides of the channel

The foregoing values of n apply only when the sectional area of stream is very large compared with the area ($L\,H$) of the weir If L is greater than 10 H the effect of end contraction may be neglected without appreciably affecting the result, L should be equal to or greater than 3 H and p should be equal to or greater than 2 H

Ice formation has considerable effect on the flow of streams hence due allowance must be made for it It diminishes the cross section of the stream and reduces the velocity of the water Some of the rivers in the northern States have as low an efficiency as 0 per cent in winter due to ice formation In very shallow broad streams with rough bottoms the loss is very large Due allowance must be made for both the decrease of the transverse section of the stream and the reduction of the velocity of flow

The question of a good reservoir is a very important one in determining the value of a water power The use to which the power is to be or may be put should be known The size of the reservoir depends very much on the value of the land and in cold climates due allowances must be made for ice In climates where the ice freezes several feet thick the depth of the reservoir would have to be increased considerably The following example illustrates the importance of reservoirs

A certain stream has an available head of 24 feet and a flow of 6 000 cubic feet of water per minute thus giving 272 available horse power A town on the river requires [illegible]00 horse power for four hours a day for lighting purposes The power is not sufficient A reservoir might be put in to store water for the remaining twenty hours The storage area would be

$$\frac{(6\ 000)\,(\text{[illegible]}0)\,(60)}{43\ \text{[illegible]}0} = 1\text{[illegible]}$$

acres if the reservoir is one foot deep The total energy stored would be

$$\frac{(6\ 000)\,(24)\,(\text{[illegible]})\,(\text{[illegible]})}{\text{[illegible]}3\ 000} = \text{[illegible]}00$$

horse power hours giving

$$\text{[illegible]}00 \quad 4 = 1\ 37\text{[illegible]}$$

horse power for four hours which is ample for the town The energy required by the town at ten cents per kilowatt hour is worth $ 1 000 a year The total gross earnings is usually the principal factor which determines whether a reservoir may be used to advantage

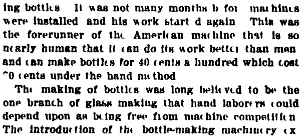

Fig 3

BOTTLES BY MACHINERY.

The bottle making machine was born of necessity A French glass manufacturer was harassed by labor troubles in one way or another until at last he shut down his plant Then he set to work trying to devise a machine that would take the place of men in blowing bottles It was not many months before machines were installed and his work started again This was the forerunner of the American machine that is so nearly human that it can do its work better than men and can make bottles for 40 cents a hundred which cost [illegible]0 cents under the hand method

The making of bottles was long believed to be the one branch of glass making that hand laborers could depend upon as being free from machine competition The introduction of the bottle-making machinery exploded that theory and when the manufacturer recites the advantages of the machine made bottle over the hand made and adds that the number of bottles broken among hand made ones was 30 per thousand as compared with 3 per thousand machine made he clinches his argument against the older method

One of the boons of the new method is the fact that pulmonary diseases which were very frequent among bottle blowers have been almost entirely overcome by the new method Passing the blowing tube from lip to lip spread contagion and the high death rate among glass blowers was attributed more to this than any one cause In the machines compressed air does the work that was hitherto required of human lungs and the sick and death rates have both fallen off since the introduction of the machines More than 2[illegible] factories are now turning out machine made bottles The Spatula

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* Power and the Engineer

GASOLINE AND ALCOHOL ENGINES.*

COMMERCIAL DEDUCTIONS FROM COMPARISON TESTS.

BY ROBERT M. STRONG.

Continued from Supplement No 1773, page 403

SYNOPSIS OF RESULTS AND GENERAL CONCLUSIONS

Some of the more important results and conclusions stated in this bulletin are summarized below

1 The low heating value of completely denatured alcohol will average 10 00 British thermal units per pound or 71 900 British thermal units per gallon

The low heating value of 0 71 to 0 73 specific gravity gasoline will average 19 00 British thermal units per pound or 11 800 British thermal units per gallon

The low heating value of a pound of alcohol is approximately six tenths of the low heating value of a pound of gasoline

A pound of gasoline requires approximately twice the weight of air for complete combustion as a pound of alcohol

The heating value of a cubic foot of an explosive mixture of alcohol vapor and air having theoretically just sufficient air for complete combustion is approximately equal to that of a cubic foot of a similar explosive mixture of gasoline vapor and air—about 80 British thermal units per cubic foot

2 Explosive mixtures of alcohol vapor and air can be compressed to much higher pressures in an engine cylinder without preigniting than can explosive mixtures of gasoline vapor and air The maximum pressure of compression that can be used without causing preignition will in each case depend partly on the quality of the explosive mixture on the design of the engine and the speed at which it is operated

For 10 to 15 horse power four cycle stationary engines of the usual type a compression pressure of about 70 pounds per square inch above atmospheric was found to be the maximum that could be used for gasoline mixtures and about 180 pounds the maximum that could be used for alcohol mixtures without causing preignition

The maximum compression pressure that could be used without causing preignition was in each case found to be the most advantageous from the standpoint of fuel economy

3 When the degree of compression is in each case that best suited to the economical use of the fuel designated some types of gasoline engines are better adapted to the service for which they are designed than similar alcohol engines and *vice versa* The relative amount of fuel consumed being disregarded this is also true when the degree of compression is that ordinarily used for gasoline mixtures as when denatured alcohol is used in gasoline engines but in general the alcohol engine is or can be so designed and constructed as to be equal to the gasoline engine in adaptability to service

A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline will when using alcohol have an available horse power about 10 per cent greater than when using gasoline

When the fuels for which they are designed are used to an equal advantage the maximum available horse power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds but of the same size in respect to cylinder diameter stroke and speed

When denatured alcohol is used in 10 to 15 horse power four cycle stationary engines having a compression pressure of approximately 180 pounds and the engines are operated at their maximum loads the pressures during explosion or combustion reach 600 to 700 pounds Stationary gasoline engines in which the compression pressure in some cases can be raised to 180 pounds are not usually built heavy enough to withstand such explosion pressures for any length of time

4 A gasoline engine having the degree of compression ordinarily used for gasoline mixtures will in general require 50 per cent more denatured alcohol than gasoline per brake horse power per hour

Gasoline and alcohol engines of similar construction having degrees of compression best suited to the fuel supplied will in general require equal volumes of gasoline and denatured alcohol respectively per brake horse power per hour

Gasoline engines of the usual four-cycle stationary type will ordinarily consume about a pint of gasoline per brake horse power per hour when operated at about rated load and with a reasonably favorable adjustment of the mixture quality and time of ignition When carrying light loads or carrying their maximum loads gasoline and alcohol engines governed for constant speed require a greater quantity of fuel per brake horse power per hour than when carrying their rated loads if rated at about 75 to 80 per cent of their maximum loads but unless the mixture quality and time of ignition are adjusted to suit each change of load the rate of consumption per brake horse power per hour will in general be least at maximum load and will increase with decrease in load

When any of the usual methods of governing are used to control the speed of gasoline or alcohol engines the rate of fuel consumption per brake horse power per hour will ordinarily be about twice as great at one third load as at maximum load At the same time an excessive rate of consumption of gasoline or denatured alcohol at any given load if due to the incorrect adjustment of the mixture quality and time of ignition only may be as great as but not greater than approximately twice the minimum required before it will be noticeable from outward indications

5 The thermal efficiency of alcohol and gasoline engines will in general increase with the pressure to which the charge is compressed when ignited

The maximum thermal efficiency of 10 to 15 horse power four cycle stationary engines of the usual type when operated with a minimum amount of throttling was found to increase with the compression pressure according to the formula $E = 1 - \left(\frac{14.7}{P}\right)^{7}$ for gasoline and $E = 1 - \left(\frac{14.7}{P}\right)^{19}$ for alcohol where E = the thermal efficiency based on the indicated horse power and low heating value of the fuel and P = the indicated pressure of the charge at the end of the compression stroke in pounds per square inch absolute

6 A high thermal efficiency and a rate of consumption of less than a pint per brake horse power per hour both for gasoline and for denatured alcohol can often be obtained when the degree of compression the load the quality of the explosive mixture and the time of ignition are carefully adjusted A fair representation of the best economy values obtained taken from the results of tests on 10 to 15 horse power Nash and Otto stationary engines and the corresponding thermal efficiencies are given in the following table

Results from Tests Made on 10 to 15 Horse Power Nash and Otto Stationary Engines

Fuel	Compression Pressure (Pounds)[1]	Fuel Consumed per Brake Horse Power per Hour		Thermal Efficiency (Per Cent)[2]
		Pound	Gallon	
Gasoline	70	0 60	0 100	25
	90	0 58	0 097	28
Alcohol	70	0 96	0 110	28
	180	0 71	0 104	39
	200	0 68	0 099	40

[1] Per square inch above atmosphere

[2] Based on the indicated horse power and the lower heating value of the fuel

7 When by means of a double carbureter gasoline and alcohol are used simultaneously in varying proportions from practically all gasoline to practically all alcohol the most advantageous degree of compression will vary from that found to be the best for gasoline mixtures to that found to be the best for alcohol mixtures

Tests that were made with such an adjustment of compression indicate that the total amount of fuel (gallons of gasoline + gallons of denatured alcohol) required for any given load is practically constant for the entire range of proportions from all gasoline to all denatured alcohol

8 When water is sprayed into an explosive mixture of gasoline vapor and air as it is being taken into the cylinder of an engine and is introduced at the most advantageous location it may in many cases be supplied in amounts up to as much water as gasoline by weight without affecting the performance of the engine except as noted below

The capacity or maximum available horse-power of an engine decreases with an increase in the percentage of water, by weight present in the explosive mixture of gasoline vapor and air

When used in an engine having a constant degree of compression, the presence of water in an explosive mixture of gasoline vapors and air in quantities equal to or less than the weight of gasoline does not increase or decrease the amount of gasoline required to carry any given percentage of the corresponding maximum available load

The pressure to which an explosive mixture of gasoline vapor water and air can be compressed in an engine cylinder without preigniting increases with an increase in the percentage of water in the mixture, and can be raised to about 140 pounds when the weights of water and gasoline are equal

That the amount of gasoline required is not affected by an increase in the compression pressure when preignition is prevented only by the introduction of water as above stated is indicated by the results of tests made on an engine having a compression pressure of 130 pounds These tests are limited however and the results are not conclusive

9 Alcohol diluted with water in any proportion from denatured alcohol which contains about 10 per cent of water to mixtures containing about as much water as denatured alcohol can be used in gasoline and alcohol engines if they are properly equipped and adjusted

When used in an engine having a constant degree of compression the amount of pure alcohol required for any given load increases and the maximum available horse power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied The rate of increase and decrease respectively is such however that the use of 80 per cent alcohol instead of 90 per cent or denatured alcohol has but little effect on the performance of the engine so that if 80 per cent alcohol can be had for 15 per cent less cost than 90 per cent alcohol and could be sold without tax when denatured it would be more economical to use the 80 per cent alcohol

When an engine is supplied with diluted alcohol, the compression pressure that can be used without causing preignition increases with an increase in the percentage of water by weight in the mixture but no tests were made to determine the effect of increased compression pressure on the economy with which diluted denatured alcohol could be used

10 The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels for marine and factory engines to be placed in the basements of office buildings in coast defense fortifications or in like places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply or where the forming of explosive or inflammable mixtures of the fuel vapors and air in the immediate vicinity would be hazardous

It is indicated by statistics and is also the consensus of opinion of those experienced in handling gasoline, kerosene and alcohol that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene but as yet the relative fire risk has not been definitely established Considerable work has been done on this phase of the investigation, and a series of tests that will be of assistance in determining the relative hazard involved in the use of these fuels is in progress at the testing station of the United States Geological Survey in Pittsburg Pa

11 In regard to general cleanliness such as absence of smoke and disagreeable odors alcohol has many advantages over gasoline or kerosene as a fuel The exhaust from an alcohol engine is never clouded with a black or grayish smoke as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete and it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied as is so often the case with a gasoline engine The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

12 Very few alcohol engines are being used in the United States at the present time, and but little has been done toward making them as adaptable as gasoline engines to the requirements of the various classes of service Engines for stationary, marine and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is in general relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available and it seems reasonable to expect that the price of denatured alcohol will eventually become as low as or lower than the price of gasoline especially if the price of gasoline advances It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

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* Bulletin published by United States Geological Survey.

When used as a fuel denatured alcohol is not always so classed as to be exempt from restrictions placed on the use of gasoline by the rules of insurance and transportation companies or city ordinances The restrictions that are placed on the use of denatured alcohol are however never greater than those placed on the use of gasoline In some places they are such that the use of an alcohol engine is permitted where the use of a gasoline engine is prohibited For instance alcohol motor trucks and automobiles are admitted to many of the steamer piers in New York that are not open to gasoline machines

Where the restrictions placed on the use of denatured alcohol are less than those placed on the use of gasoline or where safety and cleanliness are important requisites the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in the fuel expense especially if the cost of fuel is but a small portion of the total expense involved as is often the case Denatured alcohol will however probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to adaptability to service required and quantity of fuel consumed per brake horse-power which has been demonstrated to be possible becomes more generally realized

A further general development in the design and construction of engines that use kerosene or heavier distillates and the [illegible] problems may be reasonably expected and may delay the extensive use of denatured alcohol for some [illegible] but as yet comparatively few data pertaining to this phase of the general investigation are available Some investigations relating specifically to the extent and economy with which the [illegible] oils can be used as fuels for [illegible] engines of the types suited to various classes of service are however in progress at the testing station of the United States Geological Survey where a Hornsby Akroyd and a Mietz & Weiss oil engine have been installed

CAPTURED COMETS.*

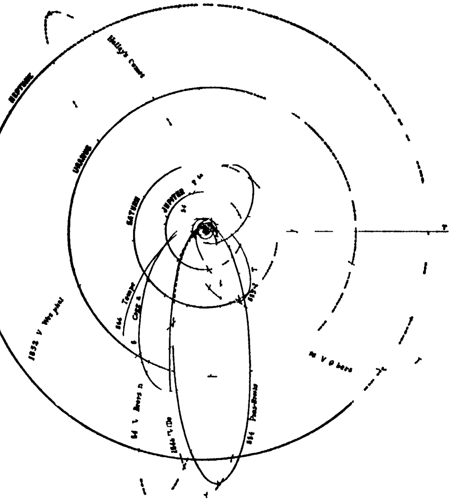
THE FAMILIES OF SATURN, URANUS, AND NEPTUNE

BY H C WILSON.

In vol vi of Popular Astronomy Plate I is a diagram of the comet families of the planets Saturn Uranus and Neptune drawn by Dr A G Sivaslian of Anatolia College Marsovan Turkey One of our readers has recently called attention to a technical error in this plate and suggested that the diagram be revised and brought up to date This we have attempted to do and the results are herewith presented

The error referred to is a technical one resulting from neglecting the inclinations of all the comet orbits to the plane of the ecliptic and drawing not their projections upon that plane but their true forms as if they all lay in that plane indicating by dotted lines the portions of the curves which lie below the ecliptic In the case of the Jupiter family of comets the inclinations are in general so small that the diagram constructed in this way gives very nearly the true projection of the family of orbits In the case of these outer families the inclinations average much higher so that a true projection would not give at all the true forms of their orbits For example the orbit of the Pons Brooks comet is inclined 74 deg to the plane of the ecliptic The line of nodes or intersection of the plane of the orbit with the plane of the ecliptic makes an angle of 254 deg with the line from the sun to the vernal equinox In order to get the true perspective of the orbit one must imagine the right side of the ellipse to be lifted up from the paper and tipped over toward the left the dotted portion being tipped downward and to the right so that the projection will appear much narrower than the true orbit and will lie almost wholly within the projection of the orbit of Brorsen's comet The orbit of DeVico's comet likewise must be tipped over through an angle of 85 deg so that it will be almost perpendicular to the plane of the ecliptic and will also lie almost wholly within the projection of the orbit of Brorsen's comet

The orbit of Halley's comet has an inclination of 162 deg and the longitude of the ascending node is 57 deg The inclination is so great that the orbit must be tipped clear over to within 18 deg of the ecliptic on the other side so that as projected its motion is backward (retrograde) and the aphelion point is in longitude 125 deg approximately instead of 345 deg as shown on Plate I vol vi where the effect of the inclination was neglected



COMET FAMILIES OF SATURN URANUS AND NEPTUNE

Tempel's comet (1866 I) also has an inclination of more than 90 deg so that its motion is retrograde Its line of nodes lies more nearly lengthwise of the orbit than does that of Halley's comet so that the change of position of the orbit when correctly projected is not so marked as in the case of the latter comet

In the diagram Plate X [illegible] have given the true forms of all the orbits neglecting the inclinations except that in the case of Halley's and Tempel's comets the orbits have been plotted to correspond to retrograde motion

In the diagram Fig 1 the true projections of all the orbits have been drawn to the same scale as on Plate X A glance at these diagrams shows at once the very marked change in position of the orbits of the Olbers Pons Brooks DeVico and Westphal comets when they are correctly projected The paths of the Olbers and Westphal comets no longer reach out to the orbit of Neptune and they should probably not be classified as belonging to the Neptune family The fact that their descending nodes are near the orbit of Jupiter would rather point to their being members of the Jupiter family

If however we take the position of the nodes as a criterion none of the six comets which have been reckoned in the Neptune group really belong there Halley's and Brorsen's have their nodes near the paths of earth and Mars DeVico's and Pons Brooks's belong to the Uranus group with Tempel's and Coggia's None of these comets in their present orbits can approach near enough to Neptune to have their orbits very seriously disturbed by that planet

Of the two comets in the Saturn group Peters's has its descending node near the path of Saturn but the nearer node of Tuttle's comet is farther from Saturn's than it is from Jupiter's orbit and it may be questionable to which planet the latter comet belongs

The elements which were employed in making the diagrams are given in Table I together with a refer-

TABLE I

ELEMENTS OF THE SATURN, URANUS AND NEPTUNE FAMILIES OF PERIODIC COMETS

Name	Period in Years	Time of Perihelion Passage Greenwich M T	Perihelion Distance	Aphelion Distance	e	ω	Ω	i	Mean Equinox	Calculator and Reference
						° ′ ″	° ′ ″	° ′ ″		
1846 VI (Peters)	12.876	1846 June 1 184	1 5?938	9 7404	0 728605	339 37 44	260 23 53	30 40 10	1846 0	Berberich A N CXVII, 251
Tuttle	13 667	1899 May 4 515	1 01918	10.4288	0 821712	206 39 09	269 49 54	54 29 16	1900 0	Rahts A N CXLIX 42
1866 I (Tempel)	33 2	1866 Jan. 11 134	0 97652	19.6747	0 905421	170 57 19	231 52 59	162 41 57	1866 0	Bidschof A N CXLIV 299
1867 I (Coggia)	40 1	1867 Jan. 20 207	1 57728	21.2502	0 865352	357 21 15	78 27 38	18 12 23	1867 0	Becker M N LI 489
1852 IV (Westphal)	60 65	1852 Oct. 12 751	1 24006	29.6363	0 919096	57 08 46	346 10 00	40 55 00	1852 0	Westphal A N L, 49
Pons Brooks	71 56	1884 Jan 25 717	0 77573	33.6680	0 954988	199 17 23	254 06 42	74 02 34	1880 0	Schulhof Bossert A N CVIII 16
Olbers	72.65	1887 Oct. 8.479	1 19912	33 6284	0.931130	64 30 11	84 32 30	44 34 16	1890 0	Ginzel Rechen Inst-Publ 3 p 33
1846 IV (DeVico)	75 71	1846 Mar. 5.546	0.66380	35.1301	0.962910	12 52 36	77 33 16	85 06 27	1846 0	Heppberger A N CXVII 245
Halley	76.0	1910 Apr. 19.66	0.58715	35.3286	0.967281	111 48 16	57 16 12	162 12 42	1910 0	Cowell and Crommelin, M N LXVIII 393 The Observatory Oct and Nov 1909
1847 V (Brorsen)	[illegible]	1847 Sept. [illegible]	0.48??	[illegible]	0 97[illegible]	129 [illegible]	309 [illegible]	19 [illegible] 00	1847 0	Gould, A J I 148

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* Popular Astronomy

ence giving the authority for each In every case we have selected what seemed to us to be the most reliable elements which have been published Those of Halley's comet are being revised by the aid of recent observations and so will be subject to slight changes but the time of perihelion passage is now known within a small fraction of a day and the other elements cannot change very much

Of the ten comets four only have been observed at more than one apparition, Tuttle's has been seen at five apparitions Pons Brooks's and Olbers's each at two and Halley's at no less than twelve successive apparitions Peters's 1846 VI must be considered as a lost comet since it has not been detected at any of its four returns since 1846 If its period is unchanged it is due again in 1913 Tuttle's and Westphal's comets are also due in 1913, DeVico's should return about 1921, Brorsen's about 1928 Tempel's in 1932, Olbers's about 1960 Coggia's was due somewhere from 1905 to 1909 but has not been detected, the period being uncertain by two or more years Halley's has recently come into sight on its return for 1910 but will not be visible to the naked eye until some time in next April or May

ACHIEVEMENT IN POLAR EXPLORATION.*

THE EXHIBIT OF THE PEARY ARCTIC CLUB.

FOR several years a record of polar exploration has been on exhibition at the Museum of Natural History in the east corridor immediately off the main foyer Here on two fifteen foot maps painted on segments of a globe fastened to the wall have been indicated the routes of Arctic and Antarctic expeditions

On September 6th the Arctic map showed Nansen's farthest north 86 deg 14 min reached in 1895 the Duke of the Abruzzi's (Cagni's) record 86 deg 33 min made in 1900 and the northernmost point of all 87 deg 6 min, gained by Peary on April 26th, 1906, but the routes went no nearer the Pole than these points, and from them stretched untraversed a region known to be more than two hundred miles wide on all sides of the Pole On September 7th, 1909, however, the red cord marking Peary's latest expedition spanned this remaining distance and a small flag floated at the center of the Arctic map to bear record to the larger American flag that was left on April 6th, 1909, waving over the drifting ice where half the year is day and half is night.

This achievement, strives for by many men of many nations, marks an event in history. It closes a con-

THE PEARY ARCTIC CLUB EXHIBIT

A great map painted on the floor shows Peary's route to the North Pole.

PRESSURE RIDGE IN NORTH POLAR ICE, SHOWING ONE OF THE DIFFICULTIES OF ARCTIC TRAVEL.

Greely Expedition June, 1881

ACHIEVEMENT IN POLAR EXPLORATION.

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* Reprinted from the American Museum Journal.

tury of Arctic research, which century in turn was the culmination of a period of three centuries of exploration, if we count the exploits of whaling and sealing vessels and the early expeditions in search of a short water route from western Europe to the Orient Some facts have been discovered some things proved not true and the field is clear for new achievement along other lines to the end that man may have a fairer understanding of the universe in which he finds himself

On the morning of October 12th an exhibition by the Peary Arctic Club was opened in the west wing of the Museum The presentation in this exhibit is unusually vivid A half hour in the hall leaves one imbued with the feeling that he has actually traveled into the untenanted world around the North Pole In the first place the exhibit is installed to give an effect of simplicity and severity of much uninterrupted space cold white surroundings and few objects Those in charge were careful not to draw on the Museum s well filled storehouses of Arctic materials to such an extent as to destroy this atmosphere of severity In the second place because of the nature of the exhibit everything speaks of adventure of a difficult life often of narrow escape and sometimes of disaster This is true throughout from the relic of the wrecked Polaris —a battered life boat that acts as a signboard just outside the entrance of the hall to the view of the Polaris in Thank God Harbor—an immense canvas at the far end Every object in the place seems to take on life as a representative of the daring work of some explorer

In imagination we see the sleeping bags displayed near the entrance with their voluminous fur folds wrapped about the traveler shutting out the savage cold We see the sledges not as mere dead frameworks of wood but as active aids to man In our awakened fancy they have iced runners and loaded with provisions they cut deep trails as with dogs and drivers they pass always on into boundless ice and snow

The mounted dog placed here to illustrate the Eskimo method of harnessing brings to mind the long double ranked teams or the fan shaped teams of eight as Peary drove them dragging their burdened sledges obeying word and whip day after day until too weak to help the expedition longer except by giving their bodies as food to strengthen their fellows while those who have read Northward Over the Great Ice recall Peary s tribute to the dogs of that journey Faithful noble servitors My only consolation is the knowledge that like ourselves you did not suffer pain The starvation was so gradual that when at last your lives went out the end was painless as our own would have been had it not been for you The mounted musk oxen the many shaggy brown pelts wound about the pillars and the numerous skulls piled upon the floor bring to mind forcefully the dependence of the explorer upon these animals for food We get a more vivid understanding of the eagerness with which he has many a time searched the ground for musk ox tracks and a more keen sympathy with his fear when he saw one or more of the great creatures that his eyes blinded by the incessant glare of the ice would give a false aim at the critical moment

The realism of the exhibit is increased by the work of a newly invented automatic stereopticon placed in a darkened alcove at the right of the hall Through its display of pictures (uninterrupted from nine in the morning until five in the afternoon) the visitor is carried into the heart of the Arctics He looks on boats and men, sledges and dogs, in action, he sees in these pictures the very mountains and icebergs the self same pressure ridges or "rafters" of ice and the leads of open water that the explorer saw in reality

AN EXPLORER S TRAIL LEFT AT THE ICE FOOT ON THE COAST OF GRINNELL LAND

Greely Expedition May [illegible]

THE "MORRIS K JESUP," A PEARY SLEDGE THAT REACHED THE NORTH POLE.

Taken on the lawn of the Museum after its return from the Arctic

ACHIEVEMENT IN POLAR EXPLORATION

The central and most striking feature of the hall is a map painted in color on the floor over a space 30 feet by 50 feet in dimensions It presents the approach to the Pole from North America only the more frequently used of the two principal paths of exploration namely the route between Nova Zembla and Franz Josef Island the direct course from Europe and that through Davis Strait Baffin Bay and Smith Sound a lane of open water stretching northward between Greenland on the east and the line of Arctic American islands extending from Labrador to Ellesmere Land on the west This map therefore does not show the route of Nansen nor does it give that of the Duke of the Abruzzi since both of these men made their approach from the Old World It does mark the points reached by Markham and Parry in 1876 by Greely in 1881 and by Lockwood and Brainard in 1882 It shows at Cape Morris K Jesup and Cape Bridgman, the limit of exploration by Peary in 1900 and marks conspicuously the 'farthest north of the same explorer as reached April 26th, 1906 The chief aim of the map however is to show the route of Peary s last or eighth expedition financed by the Peary Arctic Club

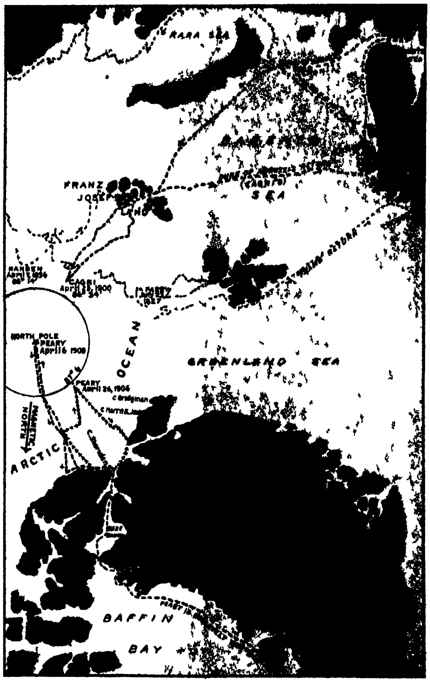
The story graphically spread out on the floor concerns more than a year s time and a distance of 800 geographical miles from Cape York northward to the Pole The expedition started from Cape York August 1st travelling up Smith Sound It reached Cape Alexander August 18th and Fort Conger September and the latter place being about [illegible] miles distant from the Pole At Cape Sheridan the Roosevelt remained in winter quarters as is indicated by the presence of a small model of the boat placed on the map at this point On March 1st a few days before the sun rose above the horizon after the long Arctic night the sledge journey began a journey of more than 400 miles over drifting ice Through these 400 miles no living thing is to be found for musk oxen and caribou range no farther north than Cape Morris K Jesup the northernmost land while seal walrus and narwhal are found only along the waters that margin the land

The rest of the trip as traced shows a veritable "dash to the Pole" On March 11th 84 deg north was passed and a week later 85 deg north was reached 300 miles from the Pole By March 27th the expedition passed 87 deg north and April 2nd 88 deg north only 120 miles from the Pole and farther north than any human being had ever before penetrated Only four days later camp was made at the journey's end and the American flag was flying at 90 deg north

There is scarcely anything in the Peary Arctic Club's exhibit outside of this map that attracts more attention than a sledge on the west side of the hall among piles of musk ox caribou and walrus hides crates of skulls and antlers and the many other things that the Roosevelt brought south with her stowed away in every available place even drying in the rigging Though only a sledge it seems deserving honor for it bears this legend A sledge that reached the Pole In reality success has come to polar exploration through use of the sledge as a means of travel

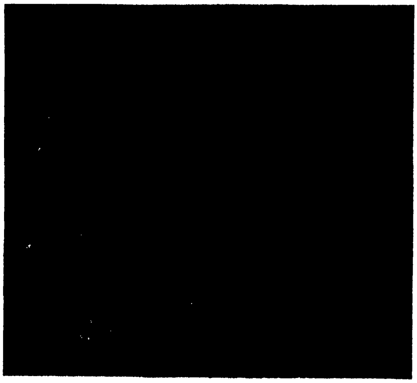
Before 1820 ships alone were used When frozen in, an expedition was delayed until a time of thaw It was not until the second or third voyage of Parry and the second of Sir John Ross that is in 1821 and 1834 that sledging expeditions began and the fact was discovered that ice which arrests the progress of the ship forms the highway for the sledge Since that time there has been great advance in sledge construction in the light of which fact it is interesting to compare the sledges in the possession of the Museum This sledge that reached the Pole is 12 feet long and 2 feet wide It consists of two wooden runners curved upward at both ends and wooden slats crossing the runners several inches apart and bound loosely to them by thongs of walrus hide Light and flexible it is able to rise and dip through the snow of steep descents without the slightest injury to itself and has surely proved its fitness for Arctic travel

The exhibit is instructive as to the manner of maintaining life in the difficult environment of the Arctics A case is filled with the skins and tools used in igloo building another contains kayaks harpoons and various fishing and hunting paraphernalia From the facts brought out here we learn the total dependence of the Eskimo on the few animals of the region particularly the walrus and the seal Still other cases contain garments of fur fur of fox seal, and reindeer They show also coats made by fastening together many small bird skins



PART OF THE NORTH POLAR REGIONS SHOWING LINES OF APPROACH FROM AMERICA AND EUROPE

ACHIEVEMENT IN POLAR EXPLORATION



A MUSK OX AND A POLAR BEAR
Peary Arctic Club Exhibit

There is much suggested also in the matter of Arctic travel aside from what has already been noted One case contains the instruments used in exploration such as sextant chronometer and compass and beside these which tell of the success of science in invention and of exploration in making use of this invention are dramatically placed various crude implements and vessels fashioned by the Eskimo from copper taken from the wreck of Sir John Franklin's ship An arching label, "A Century of Arctic Exploration," calls attention to still other cases containing the many books descriptive of expeditions to the Arctics. These books lie open at their title pages and covering the time from the work of Sir John Ross to the present, invite further investigation

As a whole the exhibit has a note of triumph in it. There is triumph, in the discoveries to science of lands and waters in the improvement in life for the Eskimo through the intervention of civilized man in the final direct route that Peary made and the American flag floating above the top of the world in the map on the floor The visitor reads also a greater triumph than these for one who has heard accounts from lips of northern explorers or has felt a choking in the throat over the experiences recorded in some of the vivid writings of these same men realizes the hardship involved in polar exploration the years of privation and physical distress of sacrifice of all that to ordinary mortals makes life worth living He knows that there has been set before the world an example of what above most things makes life worth living—the indomitable courage and perseverance that ends in accomplishment

A NEW MAP OF THE WORLD

Under the presidency of Col S C N Grant R E Director General of the Ordnance Survey as chairman a congress has just been opened at the Foreign Office of delegates of the British and certain foreign governments to consider the possibility and expediency of making a fresh map of the world The proposed scale is 1 1 000 000 or nearly 16 miles to 1 inch It is hoped to arrive at some unform set of symbols and conventional signs for adoption by all nations Some recommendations formulated by the committee constituted in London in 1895 are advocated in the name of the International Congress They comprise (*a*) polyconic projection upon each sheet independently on the middle meridian the limiting meridians being scribed at intervals of 6 deg reckoned from the meridian of Greenwich and the limiting parallels at intervals of 4 deg from the equator and each sheet showing an area of 4 deg in latitude and 6 deg in longitude (*b*) a kilometer scale with a scale in miles if desired on each sheet, (*c*) brown contour lines complemented it may be with color tints at vertical intervals of 200 meters or multiples or parts of 200 meters from sea level (*d*) the distinguishing of roads and tracts suitable for vehicles from those which are not suitable, and (*e*) Latin characters for the lettering and in different forms for natural and artificial features but to meet cases in which Latin letters are not used the sheets to be produced in two editions for national and international purposes —The Builder

To determine concrete proportions for greatest density a writer suggests experiments with a receptacle holding 4 cubic feet, as, for example a 15 inch sewer pipe By using two or three sizes of crushed stone properly proportioned a denser concrete may be obtained and cement and sand saved If there are two sizes of stone, one passing a 1½ inch and the other a ¾ inch ring, the latter should be screened to remove all that will pass a ¼ inch screen regarding this as sand Then 2 cubic feet of the smaller and 2 cubic feet of the larger stone are well mixed and put into the pipe and the top of the mixture marked on the side A mixture of 2½ cubic feet of the larger stone and 1½ cubic feet of the smaller stone and a number of other proportions are then tried, and the one giving the least volume will give the densest and strongest concrete with the least sand and cement.

USES OF BAKELITE.*

ITS ELECTRICAL AND ELECTROCHEMICAL APPLICATION.

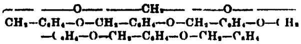
BY L. H. BAEKELAND, SC.D.

IN my first paper on Bakelite read before the American Chemical Society † I have set forth the theoretical reasons why we may consider Bakelite C or the final product, as a polymerized compound anhydride of a phenol-alcohol and methylenglycol

I have explained then and there how I have succeeded in producing this compound through indirect synthesis by the action of oxybenzyl alcohol on formaldehyde as well as by direct action of phenols on formaldehyde The latter method is the more available one for practical purposes and consists in heating under proper conditions a mixture of phenols and formaldehyde in presence of a catalytic agent preferably small amounts of bases or alkaline substances According to the conditions of operating I have succeeded in carrying out the process in three phases designated as A B and C

A is the initial product of condensation produced by elimination of water and contains probably one or more hydroxyl groups in its molecule

B is the so-called intermediate condensation product a higher anhydride evolved by further elimination of water In the case of ordinary phenol we then have oxybenzyl methylenglycol anhydride the formula of which may be represented as



$$\overbrace{\qquad}^{}\ \overbrace{\qquad}^{O}\ \overbrace{\qquad}^{CH_2}\ \overbrace{\qquad}^{O}\ \overbrace{\qquad}^{}$$
$$CH_2-C_6H_4-O-CH_2-C_6H_4-O-CH_2-C_6H_4-O-CH_2$$
$$-C_6H_4-O-CH_2-C_6H_4-O-CH_2-C_6H_4$$

C is the polymer of B and can be represented by

$$n(C\ H_nO\ )$$

or its homologs in case the other members of the phenol series be used

It is the final condition in the bakelite process This product C is characterized by the following properties

It is a hard structureless mass which may be prepared in transparent or in opaque condition its color varies from that of colorless glass to amber color or dark ruby or brown It is harder than shellac hard rubber or celluloid but misses the flexibility of the two latter substances and this is its main defect On the other hand it withstands all solvents and most chemicals resists boiling water steam and superheated steam and oils Heating does not melt it nor even soften it to any serious extent Boiling concentrated sulphuric acid destroys it so does concentrated nitric acid but it withstands dilute sulphuric acid hydrochloric acid and chlorine It can stand temperature of 300 deg C and over At the temperature of melting glass it chars and carbonizes without entering into fusion In its final condition it can be sawed cut bored and turned on the lathe but it can no longer be molded for practical purposes In other words when it has acquired condition C it is no longer a true plastic so that all operations of molding or shaping must preferably be carried out in its earlier stages In its final stage it is tasteless and odorless and an excellent insulator of heat and electricity

In cost of production it can very advantageously compete with any known plastic

For all practical purposes we use A as raw material to start with The latter is obtained in four varieties each of which may be preferable according to the special purpose in view

Extra thin liquid A is a thin liquid of great penetrating power and therefore is best fit for impregnating such bodies which absorb liquids with some difficulty as for instance wood

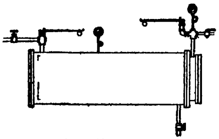
Liquid A is another variety of which the consistency is about that of molasses syrup It can be made considerably thinner by slight heating Longer heating at 60 deg to 70 deg C thickens it gradually so that it can become pasty, still longer heating at this temperature may convert it into B which is no longer fusible but still remains soft while hot

Dissolved A is a mixture of A with a small amount of alcohol which can be further diluted to proper strength by the proper addition of alcohol If an excess of alcohol be added to it the whole dissolved mass may reprecipitate and separate itself in two layers, a lower viscous one containing the precipitated A, and a supernatant thin liquid containing mainly the added alcohol Acetone redissolves this precipitate The alcoholic solution dries in about the same way as shellac varnish, but drying at ordinary temperatures or even somewhat higher temperatures does not bring the layer beyond the stage A, in other words this varnish layer remains fusible and soluble Only at relatively high temperatures and in presence of suitable amounts of catalytic agents does it transform finally in hard soluble C In all cases where the coating is rather thick or where it is applied on porous surfaces like wood it becomes absolutely essential to carry out the heating in a bakelizer under suitable pressure as explained below so as to avoid air bubbles and blistering

Solid A A brittle irregular opaque translucent or transparent mass of about the consistency and brittleness of ordinary rosin or colophonium It can be made in different degrees of hardness from a variety which melts at 40 deg C or under to a modification which melts only at 100 deg C or over If heated for a few hours at about 70 deg C it slowly hardens more and more then changes into B The main characteristic of Solid A is that it still is fusible and soluble in caustic soda as well as in acetone or in a mixture of alcohol and acetone

It can be easily ground to a fine powder and mixed with any variety of fillers and thus become very well suited for the manufacture of molded objects

Solid A at first sight resembles very closely B it has the same appearance is about of equal brittleness but B if heated does no longer melt although it softens and becomes rubber like Furthermore B is insoluble in neutral solvents acetone and phenol may swell it somewhat but not dissolve it How the valuable properties of A are utilized in practice we shall see later on



A BAKELIZER

In the different modifications of the bakelite process the aim in view is to produce the final product C but in as far as C is no longer plastic all forming shaping molding or mixing is carried out in the earlier stages

This is accomplished either by transforming directly A into C in one single operation or in other cases specially in rapid molding processes it is found more convenient to change A into B then remove B from the mold and afterward change it into C without the use of a mold In some other case the molding or shaping process is started from B and the latter is then changed into C by the application of heat

Whether stage C is arrived at directly from A or indirectly from B the quickest result and the best product is obtained by heating at relatively high temperatures say 160 deg C or over But as at temperatures above 100 deg C A dissociates into gaseous products and causes the resulting mass to be porous and spongy I found it necessary to heat under pressure Without this precaution the resulting mass will be technically worthless

If the heating occurs in closed molds or closed vessels the so developed internal pressure may be sufficient to counteract the chemical dissociation which causes porosity

In all other cases the heating should be conducted in a so-called bakelizer as shown by sketch

This is an apparatus consisting essentially of an inner chamber where the objects are placed and in which by means of a suitable pump air can be compressed to 100 or 120 pounds this pressure is maintained during the heating A steam jacket heats the chamber to a temperature of 140 deg to 180 deg C equivalent to about 54 pounds to 150 pounds of steam

The higher the temperature the shorter will be the bakelizing process which converts everything into C

In such cases where Bakelite is used in presence of substances which cannot stand such high temperatures as for instance wood wood pulp or paper somewhat lower temperatures should be used and the operation takes more time All these conditions have to be adjusted after direct experiment for each different material For substances like asbestos or other mineral fillers it does not matter if temperatures as high as 200 deg C and very long bakelizing be used

The different applications of bakelite can be divided summarily into block-working processes impregnating processes coating processes and molding processes

In some cases one or more of these processes are carried out conjunctively

Block working This process suggests itself naturally to the mind and can be carried out in many ways The simplest manner is to heat a mixture of phenols and formaldehyde under pressure in presence of a condensing or catalytic agent say a small amount of a base But it is more advantageous to start with one of the varieties of A described above The A may be simply poured in a mold or mixed first with pigments colors or suitable filling materials for instance asbestos clay mica bone black iron oxide sawdust wood pulp finely divided metals mica abrasives graphite etc and thus produce an endless variety of compositions more or less suitable for certain special purposes By heating the mass at 140 deg to 180 deg C under suitably increased pressure the whole solidifies to a solid block which has the exact shape of the container and can easily be removed therefrom because there is a slight shrinkage The process may take from one to two or three hours according to the size of the block the temperature and the amount of base used If organic fillers are used which are destroyed by too high temperatures as for instance wood pulp then the minimum temperatures must be preferred and the time of heating must be increased accordingly No such restrictions exist for mineral fillers

The so obtained blocks can now be sawed cut turned polished and shaped in about the same way as ivory or bone is handled

For large blocks the following difficulty presents itself In the final act of polymerization the mass contracts in volume and as it is rather difficult to carry out the heating in a sufficiently gradual manner it may happen that the crust is transformed in C before the heat has made its full action felt in the center This may cause rents or cracks through the mass Furthermore C is very hard and difficult to cut saw or turn Therefore it is easier to simply continue the heating until stage B is reached and then cut the latter to the proper shape then B is submitted to further action of heat until it is changed into C

I should mention that B while slightly warm is soft and somewhat elastic and cuts about as easily as Swiss cheese yet if heated further it does not liquefy nor change its original shape The transformation of A into B does not need to be carried out under pressure It may be accomplished simply by heating for a few hours at temperatures not exceeding 70 deg C any of the varieties of A either in an air stove or in a water bath The progress of the reaction can be easily followed by the touch The A will thicken more and more until it is no longer fusible and feels elastic in about the same way as coagulated gelatine When this stage is reached B can be removed from its receptacle and be cut to proper shape or the block can simply be cooled and stored away for future purposes On cooling B becomes hard and brittle but if dipped in hot water it becomes soft again and regains its former elasticity

In order to change B into C it can be heated to proper temperature in a bakelizer as described above B is no longer attacked by hot water as A is and for that reason it may be simply heated in an ordinary autoclave containing water in about the same way as rubber is vulcanized for dental purposes with this difference however that higher temperatures should be used than are permissible in the rubber process

Molds are here entirely superfluous and the objects so treated will retain perfectly their shape Temperatures of 160 deg C to 170 deg C are quite suitable but I have used with impunity temperatures as high as 200 deg C and over

I mention this fact for persons who are acquainted with rubber vulcanizing and who are inclined to carry out bakelizing at too low temperatures or too short a time indeed over vulcanizing is a constant menace to the rubber manufacturer

Plates blocks and objects of various sizes and dimensions may thus be manufactured easily but this process however simple does not commend itself in such cases where large quantities of articles of the same size have to be produced For such purposes it is much cheaper to mold in the press which allows quick and accurate work without further necessity of milling or machinery or polishing How this is done is described under the heading of molding processes

(To be continued)

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* A paper presented at the Fifteenth General Meeting of the American Electrochemical Society at Niagara Falls, Canada, May 6th to 8th 1909 See SUPPLEMENTS, Nos. [illegible] [illegible] and [illegible] on Bakelite.

† See Journal Indust. and Eng. Chemistry, March, 1909, 149 Electrochem. and Met. Ind., March, 1909, [illegible]

MOVING PICTURES OF MICROBES.

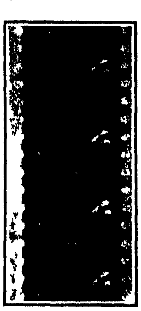
THE CHRONOPHOTOGRAPHY OF THE INVISIBLY SMALL.

BY R. VILLERS.

The cinematograph has entered a new field. It now shows us moving pictures of a world which is invisible to the naked eye and is revealed only by the microscope. This memorable achievement has been accomplished by the ingenious experiments which have been conducted with great patience and perseverance during the past year by Dr Comandon with the aid of apparatus furnished by Pathé Brothers the well known film makers.

The idea was suggested to Dr Comandon by his studies of blood parasites with the microscope and the ultramicroscope. In the classical method of microscopic examination the object is placed on the stage of the microscope and illuminated from beneath so that the light which passes through the instruments to the eye has already traversed the object the details of which appear in black on a bright background. It is necessary for this method of examination that the object shall be more or less translucent but most microscopic organisms are so transparent that they cannot be seen in the intense light unless they have been stained with certain dyes which are absorbed to different degrees by their various parts. It is often necessary to poison the organisms in order to keep them motionless. Hence the microscope shows merely an enlarged picture of colored corpses. In another method of using the microscope the objects are illuminated from above are seen by reflected light and appear bright on a dark background. In the ultramicroscope the preparation is illuminated by an intense beam of light incident at right angles to the axis of the instrument. The sizes and forms of objects are not clearly revealed but organisms and other solid particles which are far too small to be even detected by the ordinary method of using the microscope appear as bright points on a black background and their position and movements can be clearly perceived.

Dr Comandon has succeeded in photographing these animated scenes as well as those revealed by the ordinary microscope and in reproducing them as moving pictures projected on a screen. The method of accomplishing this result was indicated by Victor Henri who had already employed this method in studying Brownian molecular movements. These moving pictures of microscopic and ultramicroscopic scenes transport the observer to a new and strange world. A tadpole's tail appears as a mass of cells traversed by a river of blood in which the oval blood corpuscles are whirled along like pebbles in a swollen mountain brook. A drop of bird's blood photographed by reflected light shows elongated red corpuscles drifting slowly in a liquid filled with minute white specks. These are globules of oil and their presence in the blood indicates that the bird had eaten fatty food a few hours before the blood was drawn. In some parts of South America the poultry yards are decimated by the ravages of *Spirochetes gallinarum* a blood parasite which is nearly related to the germ of syphilis. In the magnified moving picture of the blood of an infected fowl these parasites are seen as corkscrew shaped objects moving rapidly among the blood corpuscles in the manner of eels but backward as well as forward. Sometimes one passes through another and chains of two or three spirals joined end to end are formed. Suddenly, one of the quickly moving corkscrews enters a hole in a deteriorated red corpuscle and remains imprisoned twisting and turning violently in a vain effort to find the outlet. Others follow it into the trap but succeed in making their escape. A large white corpuscle moving slowly in the manner of an amœba encounters a deteriorated red corpuscle which it envelops and proceeds to devour or absorb. The dark background of this strange scene is dotted with bright oil globules.



PART OF POSITIVE FILM, SHOWING BLOOD OF A HEN INFECTED WITH SPIROCHETES

APPARATUS FOR MAKING MOVING PICTURES OF MICROSCOPIC OBJECTS

A drop of the blood of a mouse infected with a trypanosome nearly related to the germ of the sleeping sickness is shown in another series of moving pictures. The actual length of the trypanosomes ranges from 1/1250 to 1/250 inch but on the screen they appear like giant caterpillars a foot or more in length. They advance somewhat in the manner of caterpillars by the undulating movements of a special membrane. The body is swollen at the posterior end and sharply pointed in front. The swiftly moving trypanosomes collide violently with the red blood corpuscles which like rubber balls are indented by the shock but instantly regain their normal spherical shape.

These few examples must suffice to illustrate the great scientific interest of Dr Comandon's projections. These superb moving pictures of an invisible world can be studied at leisure and repeatedly with the attention devoted entirely to the phenomena under observation. In the ordinary method of microscopic study the observer must simultaneously examine the object keep it in focus and draw and describe it as accurately as is possible in such conditions. The moving pictures also afford an admirable means of teaching.

The apparatus by which these films are produced is shown in an accompanying illustration. A small and intense pencil of light produced by a 30 ampere electric arc lamp is concentrated upon the object by a closely stopped lens either directly or (in ultramicroscopic work) by means of a mirror which reflects the beam in a direction perpendicular to the axis of the instrument. The microscope is placed horizontally and projects a real magnified image of the object upon the strip of film which moves intermittently behind it. A small hole in the back of the camera allows the image projected on the translucent film to be observed with a magnifying glass so that the focus can be adjusted and the position of the object in the field altered as may be required.

One of the greatest difficulties encountered by Dr Comandon was caused by the heating effect of the powerful beam of light which killed many micro-organisms in a few seconds. This difficulty was overcome by interposing in the path of the beam, a disk with alternate sectors cut out and causing the disk to rotate in synchronism with the cinematograph, so that the preparation is illuminated only during the actual exposures of the film and the light is cut off during the intermediate and equal intervals (1/32 inch) which are occupied in moving the film. The rays also pass through a glass cell traversed by a current of cold water which absorbs much of the non luminous but strongly heating radiations.

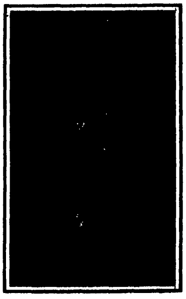
A magnification of 10 000 diameters is obtained by this method. With this enlargement a flea, if it could be shown entire on the screen would appear as large as a six-story house.—La Nature

* * *

The following method of painting a cement wall was described at a recent convention of Canadian master painters. The building had become discolored in places and the joints were of a different color from the surface of the blocks. Two parts of Portland cement together with one part of marble dust were mixed with water to the consistency of thin paint or a thick whitewash. The wall was well wetted before the application of this paint and kept constantly wet while the material was applied and then kept for a day in order to make the cement wash adhere to the cement surface. The wash was applied with ordinary whitewash or calcimine brushes and a man was kept busy playing a spray on it while the work was being done. The whole secret of success lay in keeping the wall constantly wet.

CHINESE WILD SILK

Wild or so called mountain silk is produced by the oak bombyx (*Antheraea Pernyi*) silkworm the eggs of which are imported from Ho Nah. For some time past only cocoons have been supplied to Kweh Chu and Tze Chuan—the center of the wild silk industry. The price of cocoons per wan (myriad) varies from 30 to 3 taels (1 tael = about ¾ cent) but those containing females fetch 10 taels per 1 000. One female produces about 40 worms. Ten thousand cocoons yield about 10 ounces of silk. Of course these figures are only an average as they vary up or down a little according to good or bad years. These cocoons require greater care than is required for the ordinary domestic silkworm. The Chinese hang them up in their houses choosing a humid dark spot where the temperature is always constant and they are carefully guarded from the sun. The buffalo stable is generally the place selected. About the end of January the cocoons are removed to a large room in which they are hung up all the windows and apertures are carefully closed except a hole in the ceiling for the escape of the smoke from a wooden stove placed in the middle of the room. It is left alight for about 20 days day and night when the moths emerge and immediately attend to domestic business. Each female lays about 60 eggs which are ten times larger than those of the ordinary silkworm. The worms (which are born in about 15 to 20 days) are collected in baskets and taken to the mountains where the dwarf oaks (*Cudrania triloba* Hance) grow upon the leaves of which the worms feed. For 60 days the worms continue to grow and they then spin their cocoons the silk from which is wound off and spun toward the end of May. The chief centers of production of wild silk are the towns of Ki Kiang Fu kwang pa and Tohe ho Chen in Se-Chuan and the towns of Tseng yi fu Ma Chen Miao-t ang Ngan tse ki and Tseng Ngan in Kweh Chu. There are two qualities—'coarse and fine", the former is made from a thread formed from 30 cocoons, and the fine from one from 8 cocoons. The price varies, but is usually about 340 taels per picul but a couple of years ago it was 225 taels, it depends upon quantity and quality, fine silk is from 10 to 15 taels dearer than the coarse.



PART OF NEGATIVE FILM, SHOWING BLOOD OF A MOUSE INFECTED WITH TRYPANOSOMES

This 'wild silk," which is known in Europe as "watereel, is sent to France, where it is milled (at Lyons and Avignon) and then sent to America where it is made up into a stuff called "rajah." It is also now being largely used in aeronautics for the manufacture of gas bags, for which the silk is found to be highly suitable, owing to its tenacity.

MICROSCOPIC TREE-FUNGI.*

SOME MINUTE PARASITES.

BY JAMES SCOTT

The great hindrance to the study of the microscopic fungi is their objectionable character to the naked eye and their frequently obnoxious odors A piece of rotting twig, cabbage stalk or some comestible may carry immense quantities of exceptionally interesting fungi but there is little persuasion toward studying them when it is found necessary to handle the disgusting stuff Moreover another disadvantage that tends to keep fungi in the background is that owing to their universally delicate structure—a mere touch is often sufficient to demolish a symmetrical group—they cannot all be purchased as mounted specimens on microscopical slides

The following examples of microscopic tree fungi are grouped together because they were all obtained at the same time from the same pieces of twig etc In addition to picturing the fungi as nearly natural size as possible in the smaller circles it may be advisable to regard the circles as enlarged pinholes Nos 3 5 6 and 8 representing those made with the point and Nos 1 4 9 10 and 12 with the shaft of a 1½ inch pin In other words the first circles are with a 1¼ inch objective, and the second ones with a ½ inch objective

The genus, of which *Botrytis cinerea* is a good example has several representatives that are parasitic on garden and farm vegetation This particular specimen has simply branched dark olive stalks along which ashy, or gray, bunches of spores are arranged as shown in No 1 The style of secondary branching by which the spores adhere to the stalks can be understood by referring to the right hand space of the figure

The coral spot fungi (No 2) are great pests to the fruit grower They are, in themselves, very pretty objects, and dot the stems and trunks with bright red densely scattered warts like small seeds There is a great similarity between the various species, and the typical genus depicted in the figure may be regarded as representing them all In their first stages they are bright colored, and discharge their spores irregularly, but in their second stages they become rather dull in tint, and the spores are arranged in pear-shaped *perithecia* clustered together In reality, a *nectria* splits gradually into these *perithecia* A hole in the summit of each of the latter allows for the liberation of the spores. The majority of forest trees are open to the attacks of these compact fungi

One of the most delicate kinds of fungi is that displayed in No 3 Fairly long slender, unbranched stalks support at their summits either one, two three, four, five, or six individually divided spores Usually the number is three The spores are jerked off when ripe by the corkscrewing of the stalks To the naked eye this fungus appears as scattered white glistening patches each patch composing what in reality is a miniature thicket This specimen is *Trichothecium obovatum*

Another very different style of white fungus is the *Volutella ciliata* in No 4 To the unaided sight it might on account of its mealy appearance be mistaken for the last mentioned example though no experienced microscopist would be thus deceived The whole dot is really a spore case and is strongly defended against the attacks of mites by numerous stiff bayonet like projections pointing in all directions

The group of which the present *Torula pulveracea* (No 5) is a good example may be appropriately called necklace fungi The transparent spores are set end to end in tree like tufts as shown Of course each spore is capable of setting up a whole *mycelium* bed on its own account in a suitable *nidus* and so it gains over many more elaborately contrived fungi in that it is practically all seed so to speak

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6.

FIG 7 FIG 8 FIG 9 FIG 10 FIG 11 FIG 12

1 Botrytis Cinerea. The bunch spray fungus, magnified Shown on a sixpence proportionately A small branch is more magnified in the right hand space, while the upper left hand circle shows a pin hole proportion of the growth 2 A common Nectria " Coral pear fungus" each mass being about the size of a pin s head 3 Trichothecium Obovatum The frail bead fungus magnified About life size in the small circle. 4 Volutella Ciliata The spring knob fungus, magnified Compared also with a sixpence 5 Torula Fulveracea The necklace fungus magnified About life size in the small circle which proportionately represents a sixpence 6 Pistillaria Puberula The prickly-club *fungus* magnified Shown life size on a sixpence 7 *Outgrowths due to mites The ribbon snake fungus magnified and about life size* on a sixpence 8 A species of Isaria The tiny pin fungus magnified Shown life size on a sixpence 9 Common myxomycetes The stalked globe fungus magnified Shown life size on a sixpence 10 A species of Dendryphium The divided gem fungus magnified Compared also with a sixpence To the right is shown more highly magnified, one of the gems or spores 11 A myxomycete covered with a parasite The bristle-fan fungus magnified Shown about life size on a sixpence 12 Sporodinia Dichotoma. The pearl fungus. Compared with a sixpence

The *Pistillaria* are club shaped fungi strikingly resembling the *Clavaria* Indeed the chief differences are those of size, the first being minute and the second of much larger dimensions *Pistillaria puberula* which I picture in No 6 has a powdery white sporophore or club One member of this genus *P micans* is a beautiful glossy rose-colored object that is most charming under the microscope

The specimens that I exhibit in No 7 are so widely classed as fungi by naturalists and are so common that a few words should be given concerning them They appear like tiny collections of twisted faintly golden or pale brown hair emanating from scattered parts of the wood When moistened, they wriggle about like a nest of serpents and liberate dust which apparently consists of spores, yet Mr W B Grove a mycologist of much experience, tells me that they are simply outgrowths due to the attacks of mites

The genus *Isaria* are minute prickly or mealy fungi as can be seen by referring to No 8 Rough projections get thickly covered with variously directed stiff pin like objects, the heads of which are the spores Color is the chief distinguishing feature of this genus and it is not necessary to go further into their usually simple structure

The *Myxomycetes* are, by many of the advanced cryptogamists considered as quite distinct from the true fungi In the present instance however it will not be a very perfidious act if I regard them as belonging to the subject, in conformity with the opinions of older naturalists No 9 is an example having either dark brown or black stalks and fluffy globular heads of a grayish or whitish tint No 11 depicts another specimen covered with a parasitic fungus allied to the *Penicillium* or blue molds

A *Dendryphium* is given in No 10 in which the transparent spores are pale green when flattened between slips but appear very dark previously The particular style of the genus can be gathered by noting the method of growth and the positions of the divided spores one of which is magnified to greater proportions at the side of the circle

A rather curious Y branched fungus is the *Sporodinia dichotoma* The pearl like spore heads occupy the extreme tips of the rusty brown plant as a rule but frequently at the bases another form of reproduction often to be encountered also in the *Mucorini* or pin fungi comes into operation Two or more spore cases meet together and ultimately coalesce the *gametes* as they are then called forming a single strong spore cell Sometimes one is apt to confound two or more species of fungi together when observing these stages as they twine together like the bushes and plants of a hedgerow

Everyone *of these* examples *came from* trees having grown chiefly on the thinner stems and twigs Odd broken pieces of dead trees stood in water within large glass-covered jars and left undisturbed for some days will almost surely develop many of these fungi but it may be necessary to hunt about for some species

The *mycelia* or hidden threads send up aerial stalks or *hyphæ* on which the varying characteristic fruits are carried

When I examine the fungi I merely hold the stem beneath the microscope and revolve it gradually so as to bring all its circumference into the field of view Of course this causes the outside to appear as a horizon from which protrude the fungi in an undisturbed condition Some species can be transferred with a needle *to a slide, though this plan needs great carefulness* A drop of water on the slide into which some specimens are dropped will assist their definition

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The author of an article in the Frankfürt Vulkan deals with the industrial prospects opened up by the possibility of producing pig iron electrically in considerable quantities as demonstrated by recent successes in Sweden where it is stated various works are putting the Grönwall Lindblad Stalham process to practical use According to the authority named the cost of producing pig iron by electricity is 16 per cent less than that entailed by ordinary smelting methods

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* Knowledge and Scientific News.

THE EFFICIENCY OF MODERN AEROPLANES.

WITH FULL DATA COLLECTED AT THE RHEIMS AVIATION MEET.

BY G. GARNIER.

After the splendid success of the great aviation week at Rheims it would seem superfluous to proclaim before the world the undeniable progress made by aviation during the last few months and now that the general public has realized the interest in mechanical flight we can look to the near transformation into a flourishing industry of what heretofore has been chiefly experiment in the interest of sport.

The conclusions to be drawn from the Rheims meet may be summarized and expressed in figures thus:

Pilot's importance 60 per cent; motor's importance 30 per cent; importance of the machine itself 10 per cent.

By this we mean that if at the present time any rationally studied apparatus is more or less apt to fly the motors for aviation purposes are yet very precarious and that there is not one from which the same quality of performance can be expected three times in succession.

We mean also that an apparatus that has produced marvelous results in the hands of a certain pilot is for the time being condemned to fail or to become useless in the hands of ten other operators.

The present-day pilot must in fact know his machine as well as the constructor and the designer themselves know it; he must in some sort be capable of establishing again by reasoning and scientific means not by routine or from memory the data concerning it; besides he must be a good mechanic in order to get out of present-day motors all they can yield; and lastly he has to be a good air navigator knowing how to watch the movements and variations of his machine and to feel it by instinct so to speak.

We may be attributing to the pilot an extraordinary importance but we do not however exaggerate when we state that from him the builders have principally to expect the daily improvements that will enable amateurs gradually to learn how to manage an aeroplane just as they manage now a 60 horse-power automobile.

But there is another lesson to be learned from the Rheims meet for this is the first time that we have come into possession of serious information enabling us to make a comparative study of the different types of aeroplanes on essentially different trials such as endurance speed and weight carrying. At Rheims these tests were respectively the Grand Prix de Champagne, Bennett Cup race and speed prize, and the passenger carrying prize.

In order to render comparisons easier we will make use of the expression "Coefficient of utilization of an aeroplane" (Revue de l'Association Générale Automobile, Jan. 1909.)

In practice what is asked and specially what will be asked of an aeroplane is to carry the maximum useful load with the minimum dead weight at the highest speed and with the minimum of propelling power (in other words of expenditure of energy).

If therefore we call—

P_u — the useful load (pilot and passengers or merchandise)

P_t — the total weight (including the useful load the machine complete with supplies of gasoline oil and water necessary to perform a given journey)

V = the velocity (in kilometers per hour or in meters per second)

M — the effective driving horse-power

—we have for the coefficient of utilization

$$U = \frac{P_u}{P_t} \times \frac{V}{M}$$

Let us now study the results obtained by the different types of aeroplanes in the three great kinds of trials to which they were submitted at Rheims.

I. Grand Prize of Champagne.—In this test of endurance each contestant started with the maximum quantity of fuel that he thought should be carried. The only useful load in this instance was therefore the pilot himself.

We have collected in the following table the data necessary to calculate the coefficient of utilization.

The Wright biplanes which were operated by the two Wright pilots Count de Lambert and Mons. Paul Tissandier rank first from the point of view of useful load carried. This is not surprising considering its very low resistance to advance and the excellent efficiency insured by its two relatively slowly revolving propellers.

It is also worthy of notice that these two machines similar in every respect have developed the same speed when operated by two different pilots.

The two Antoinette monoplanes, both piloted by Mons. Hubert Latham come next. The proportion of useful load to total weight with these monoplanes is one third less than with the Wright biplanes. This is due to the Antoinette's motor having a greater weight per horse-power than the Wright 4.7 kilogrammes (10.36 pounds) instead of 3.6 kilogrammes (7.93 pounds) also to the single propeller turning at 1,100 r.p.m. which gives only 265 pounds pull and seems to work under some disadvantage by comparison with more slowly revolving propellers; lastly to the fact that the position of this propeller in front of the plane diminishes the lift while the stationary horizontal and vertical fins forming a tail absorb a certain amount of power which is compensated for nevertheless by a greater stability in flying.

TABLE A.—GRAND PRIZE OF CHAMPAGNE.

Rheims Classification	Make Aeroplane and Motor	Pilot	Useful Load P_u [1]		Weight of Aeroplane with Motor and Supplies		Gasoline Oil Water		Total Weight P_t		Speed in Kilometers per Hour V		Effective Driving Power M	Practical Coefficient of Utilization $U = \frac{P_u}{P_t} \times \frac{V}{M}$
			Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kms.	Mls.	H. P.	
I	H. Farman (Gnome motor)	H. Farman	70	154.3	420	925.9	60	132.3	550	1212.5	58.4	36.3	35	0.2128
II	Antoinette (Antoinette motor)	H. Latham	70	154.3	390	859.8	65	143.3	525	1157.4	67.0	41.6	40	0.2233
III	Voisin (Gnome motor)	L. Paulhan	70	154.3	420	925.9	65	143.3	555	1223.6	49.1	30.5	35	0.1765
IV	Wright (Wright motor)	Comte de Lambert	70	154.3	350 + 30 [2]	771.6 + 66.1	50	110.2	500	1102.3	[illegible]	34.6	27	0.2890
V	Antoinette (Antoinette motor)	H. Latham	70	154.3	390	859.8	65	143.3	525	1157.4	67.8	42.1	40	0.2260
VI	Wright (Wright motor)	P. Tissandier	70	154.3	350 + 30 [2]	771.6 + 66.1	50	110.2	500	1102.3	62.3	38.7	27	0.3230

[1] We take for pilots in a general way a uniform weight of 70 kilos (154.3 lbs.), the small differences that in reality appear not being sufficient to alter the conclusions.

[2] To the true weight of the Wright machines we add here 30 kilos (66.1 lbs.); the Wright machines were indeed the only ones at Rheims that could not rise by themselves. A wheel attachment may be easily adapted to them not exceeding this maximum weight of 30 kilos (66.1 lbs.) and hence our comparison with the other machines remains in full force.

TABLE B.—BENNETT CUP RACE.

Rheims Classification	Make Aeroplane and Motor	Pilot	Useful Load P_u		Weight of Aeroplane with Motor and Supplies		Gasoline Oil Water		Total Weight P_t		Speed in Kilometers per Hour V		Effective Driving Power M	Coefficient of Practical Utilization $U = \frac{P_u}{P_t} \times \frac{V}{M}$
			Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kms.	Mls.	H. P.	
I	G. H. Curtiss (Curtiss motor)	G. H. Curtiss	70	154.3	230	507.1	15	33.1	315	716.5	75.7	47.0	35	0.4806
II	Blériot XII (E. N. V. motor)	L. Blériot	70	154.3	520	1146.4	25	55.1	615	1355.8	75.3	46.8	50	0.1714
III	Antoinette (Antoinette motor)	H. Latham	70	154.3	390	859.8	25	55.1	485	1069.2	68.4	42.5	40	0.2468
IV	Wright (Wright motor)	E. Lefebvre	70	154.3	350 + 30	771.6 + 66.1	20	44.1	470	1036.2	57.8	35.9	27	0.3188
French Eliminatories	Wright (Wright motor)	P. Tissandier	70	154.3	350 + 30	771.6 + 66.1	20	44.1	470	1036.2	62.8	39.0	27	0.3464
	Voisin (Gnome motor)	L. Paulhan	70	154.3	420	925.9	15	33.1	505	1113.3	55.9	34.8	35	0.2019
	H. Farman (Vivinus motor)	R. Sommer	70	154.3	470	1036.2	20	44.1	560	1234.6	51.3	31.7	35	0.1832

TABLE C.—SPEED PRIZE.

Rheims Classification	Make Aeroplane and Motor	Pilot	Useful Load P_u		Weight of Aeroplane with Motor and Supplies		Gasoline Oil Water		Total Weight P_t		Speed in Kilometers per Hour V		Effective Driving Power M	Coefficient of Practical Utilization $U = \frac{P_u}{P_t} \times \frac{V}{M}$
			Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kms.	Mls.	H. P.	
I	G. H. Curtiss (Curtiss motor)	G. H. Curtiss	70	154.3	230	507.1	20	44.1	320	705.5	75.0	46.6	35	0.4687
II	Antoinette (Antoinette motor)	H. Latham	70	154.3	390	859.8	30	66.1	490	1080.3	68.9	42.8	40	0.2461
III	Wright (Wright motor)	P. Tissandier	70	154.3	350 + 30	771.6 + 66.1	20	44.1	470	1036.2	62.1	38.6	27	0.3426
IV	Wright (Wright motor)	Comte de Lambert	70	154.3	350 + 30	771.6 + 66.1	20	44.1	470	1036.2	62.0	38.5	27	0.3420
V	Wright (Wright motor)	E. Lefebvre	70	154.3	350 + 30	771.6 + 66.1	20	44.1	470	1036.2	61.95	38.5	27	0.3417
VI	Blériot XI (Anzani motor)	L. Blériot	70	154.3	230	507.1	10	22.1	310	683.4	59.6	37.0	25	0.5383
VII	H. Farman (Vivinus motor)	R. Sommer	70	154.3	470	1036.2	25	55.1	565	1245.6	57.6	35.8	35	0.2039
VIII	Voisin (Gnome motor)	L. Paulhan	70	154.3	420	925.9	15	33.1	505	1113.3	54.8	34.0	35	0.2170

Mons. Henry Farman's biplane follows very closely the "Antoinette" monoplane, its head resistance is greater, but it makes up partly for this defect by the use of a very light revolving-cylinder air-cooled motor (the "Gnome").

Mons. Paulhan's Voisin biplane comes last, its very great head resistance is the price it pays for its automatic stability and great dead weight.

II.—Bennett Cup Race and Speed Prize.—In these two speed tests the only useful load carried was again that of the pilot, the supplies of gasoline, oil, and water had been reduced to the strict minimum for

The Blériot XI of the cross channel type (machine

these two flights 20 and 30 kilometers (12.4 and 18.6 miles) respectively.

No. 23 at Rheims) came in a good first and that was not at all surprising because 1st. It was made for one person. 2nd. It was a monoplane having very little head resistance. 3rd. Its dead weight was very small. 4th. Its motor was small and light.

Curtiss's aeroplane followed closely, its total weight was nearly the same but its head resistance was a little greater and its higher speed required greater driving power.

Nevertheless it must be noted that these two machines made expressly for speed and for only one passenger are separated only, from the point of view of practical utilisation, by the inherent difference in their system of construction (biplane against monoplane).

After these two machines come the Wrights, the regularity of their useful effect is remarkable, for this type of machine made for length of flight or for passengers, could not be expected to take first place in tests of pure speed. Their coefficients of utilisation, with different pilots, are remarkably close to each other, the only apparent anomaly is in the case of

Lefebvre in the Bennett Cup race, but that is due to poor adjustment of his machine, which was never good at any time during the meeting, but which proved to be worse on the cup day; bad balancing of this machine cost him the loss of 3 to 4 miles an hour of speed

The "Antoinette" comes after the Wright, in the same proportion as for the Grand Prize of Champagne (one-third less utilization).

Mons Paulhan s Voisin biplane owes to its light motor the advantage gained over Mons Royer Sommer s Farman, which was handicapped by the weight of its 35 horse-power 8-cylinder water cooled Vivinus motor

The "Blériot XII (No 22) came in a good last but that is hardly surprising if its dead weight and driving power are compared with those of the other machines.

TABLE D —PASSENGER-CARRYING PRIZE

Rheims Classification	Make Aeroplane and Motor	Pilot	Passengers Number	Passengers Weight Kgs	Passengers Weight Lbs	Total Useful Load Pu Kgs	Total Useful Load Pu Lbs	Aeroplan Motor and Supplies Kgs	Aeroplan Motor and Supplies Lbs	Gasoline, Oil Water Kgs	Gasoline, Oil Water Lbs	Total Weight Pt Kgs	Total Weight Pt Lbs	Speed in Kilometers per Hour V Klms	Speed in Kilometers per Hour V Mls	Effective Driving Power W H P	Coefficient of Utilization $I = \frac{Pu}{Pt} \times \frac{V}{W}$
I	H. Farman (Gnome motor)	H Farman	2	130	286 6	200	440 9	450	995 9	15	33 1	665	[illegible]	56 8	[illegible]	50	0 666
II.	H Farman (Gnome motor)	H Farman	1	65	143 3	135	297 6	450	995 9	15	33 1	570	1256 6	60 7	37 8	50	0 410
III	Wright (Wright motor)	E Lefebvre	1	65	143 3	135	297 6	350 + 30	771 6 + 66 1	20	44 1	535	1179 5	52 8	32 8	30	0 4964
At Rheims	Blériot XII (E N V motor)	L Blériot	1	65	143 3	135	297 6	520	1146 4	25	55 1	680	1499 1	70	43 5	50	0 2779
At Douai	Blériot XII (E N V motor)	L Blériot	2	130	286 6	200	440 9	520	1146 4	25	55 1	745	1642 4	65	about 40 4	50	0 3489
At Auvours	Wright (Wright motor)	W Wright	1	110	242 5	180	396 8	350	771 6	20	44 1	550	1212 5	about [illegible]	31 2	30[1]	$\frac{180}{550} \times \frac{50}{30}$ 0 5[illegible]

[1] In order to account here for the 30 kilos (66 1 lbs) weight of a wheel system attached to the Wright machine we deduct this 30 kilos (66 1 lbs.) from the useful weight carried for we do not know whether the apparatus would have risen with a total weight of 580 kilos (1278 7 lbs) instead of 550 kilos (1212 6 lbs.)

III —Passenger Carrying Prize —In Table D we have added to the official Rheims results those of the Blériot XII at Douai and at Rheims before its destruction and those obtained by Wilbur Wright at the Auvours field

As for carrying passengers Farman s biplane with two passengers on board has almost as high a coefficient of utilization as the Wright biplane (at Rheims and Auvours), with only one passenger There is therefore an advantage in favor of the Wrights aeroplanes

Finally the "Blériot XII", for the same reason that we have previously given is well behind Its great head resistance due to the defective disposition of the radiators motor and passengers also contributes in great measure to this unsatisfactory result

What is to be concluded from these different observations?

First of all that at next year's meeting it will become indispensable to organize the three kinds of tests, namely Endurance speed, and passenger carrying

Consequently builders will have to present two entirely different types one for pure speed the other for stability and passengers

In short we can even at the present time adopt for the practical utilization of existing machines such as we have defined it at the beginning the following classification

High-speed aeroplanes for one person only Blériot XI ' and Curtiss

Aeroplanes for carrying dead weight or passengers Wright, Farman, Antoinette Voisin — L Aerophile

CHARACTERISTICS OF THE PRINCIPAL AEROPLANES

	Voisin		Farman		Wright		Curtiss		Antoinette		Blériot No 12.		Blériot No 11		Santos Dumont	
	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs	Kgs	Lbs
Weight complete, without pilot	430	948	400	882	400	882	250	551	450	[illegible]	[illegible]	[illegible]	220	485	120	[illegible]
	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft
Surface of the planes	40	431	40	431	50	538	20	215	[illegible]	[illegible]	[illegible]	[illegible]	15	161	9	[illegible]
	Ms	Ft	Ms	Ft	Ms	Ft	Ms	Ft	Ms	Ft	Ms	Ft	Ms	Ft	Ms	Ft
Spread	10	32 8	10	32 8	12 50	41 01	7 80	25 6	14 80	48 6	11	[illegible]	8	26 2	5	16 4
									Trapeze.							
	Ms.	Ft.	Ms	Ft	Ms.	Ft	Ms.	Ft	Ms	Ft	Ms	Ft.	Ms	Ft.	Ms	Ft
Width of plane	2	6 56	2	6 56	2	6 56	1 40	4 59	3 2	9 84 6 56	2 20	7 21	2	6 56	1 80	5 90
	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms.	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft.	Sq m	Sq ft
Surface of horizontal rudder Fore	4	43 1	4	43 1	5	[illegible]	4.50	48 5			2 50	26 9				
Surface of horizontal rudder Aft									1	10 8			1 30	14 0	1 20	12 9
Lateral stability	Automatic.		Wing Tips		Warping		Balancing		Warping		Warping		Warping		Warping	
	Sq ms.	Sq ft.	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms.	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft	Sq ms	Sq ft
Surface aft fins	9	96 9	8	86 1	No fins		2 50	26 9	4 50	48 5	2	21 5	1 50	16 1	No fixed fins	
	Ms	Ft	Ms.	Ft	Ms.	Ft	Ms	Ft	Ms	Ft.	Ms	Ft	Ms	Ft	Ms	Ft
Total length of the machine	10 50	34 4	14	45 9	9	29 5	8	26 2	10 90	[illegible]	10	32 8	8	26 2	6	19 7
Propeller Wood Diam			2 60	8 5	two 2 60	8 5	1 80	5 9			2 80	9 2	2 10	6 89	2 10	6 89
Propeller Metal Diam	2 30	7 5							2 20	7 2						
Propeller, pitch of	1 40	4 6			[illegible]	10 6			1 30	4 3	3	9 8	0 80	2 6	1	3 3
Propeller, number revolutions of	1200		1200		450		1000		1200		600		1450		1400	
Motor	Gnome.		Gnome.		Wright.		Curtiss		Antoinette.		E N V.		Anzani.		Darracq	
Horse power of motor	50		50		30		40		55		60		25		30	
Number of cylinders	7		7		4		8		8		8		3		2	
	Mm.	Ins	Mm	Ins	Mm.	Ins	Mm.	Ins	Mm	Ins	Mm	Ins.	Mm	Ins.	Mm	Ins.
Bore	110	4 33	110	4 33	112	4 41	90	3 54	110	4 33	105	4 13	105	4 13	130	5 12
Stroke	120	4 72	120	4 72	100	3 94	100	3 94	105	4 13	110	4 33	130	5 12	120	[illegible]
Number of revolutions	1200		1200		1400		1600		1200		1800		1450		1400	
Cooling	Air		Air		Water		Water		Water		Water		Air		Water	
	Klms	Mls.	Klms	Mls	Klms	Mls	Klms	Mls.	Klms.	Mls	Klms	Mls	Klms	Mls	Klms	Mls
Speed in kilometers (Rheims results)	55	34 2	66	41	70	43 5	75	46 5	71	44 1	79 Record	49 1	55	34 2		

NATURAL GAS.

NATURAL gas is being supplied over wider areas, and it comes as both an ally and a competitor of electric lighting This dual position relates to both the central station and to the isolated plant, for natural gas may displace the lamps or operate the engines of either a public or private electric system, under same conditions

As a lighting agent at the open flame natural gas has no value, but in incandescent-mantle burners it has even greater illuminating power than good manufactured gas It is thus only in so far as mantle burners are adapted that natural gas competes with the electric light and the most important point of such competition for central stations is probably in street lighting

It has previously been pointed out that mantle burners with all their supposed advantages have been able to displace the open flame of manufactured gas to only a slight extent among ordinary consumers and it may well be doubted whether natural gas can do much more in this direction An illustration of the preference of the public for a gas that carries its own illuminating power may be noted at Buffalo where some 600 000 000 feet of eighteen candle artificial gas is annually sold at one dollar per thousand though natural gas retails at thirty two cents

In factories and stores and on streets however there is some competition between natural gas and electric light but this can often be offset by the use of gas as a source of power for electrical supply The owner of a factory that will either operate an isolated electric plant or use natural gas for lighting finds the cost less and the service better if natural gas is burned in an engine instead of in mantles

With mantle burners that consume only three and one-half cubic feet of natural gas each per hour the volume required by eight burners will give a kilowatt hour if used to drive a small gas engine and dynamo and with this kilowatt hour twenty tungsten lamps of forty candle-power each may be operated

A central station that must compete with natural gas for lighting and power will often find itself armed for the conflict by using this gas under boilers or in engines Though subject to some variation the heating power of natural gas may be taken at 900 British thermal units per cubic foot or 900 000 units per thousand cubic feet which is approximately one-and one half times the heating power of ordinary manufactured gas If a ton of 2 000 pounds of steam coal be taken to have 24 000 000 British thermal units, 26,600 feet of natural gas should make more steam than this coal, for the gas can be burned under boilers with a higher efficiency

Even better results may be had if gas engines are used to drive the electric generators for it would not be unreasonable to expect an efficiency of thirteen per cent including friction losses under reasonable conditions of load This should give twelve per cent of the heat energy of the natural gas in the form of electric current at the dynamo terminals or say thirty-one kilowatt hours per thousand feet of the natural gas used in engines In other words a combined gas engine and dynamo should deliver 900 000 × 0 12 = 108 000 heat units per thousand feet of natural gas consumed and 108 000 divided by 3 412 the number of equivalent heat units per kilowatt hour gives thirty one kilowatt hours per thousand feet of gas

In the wide area between Pennsylvania and Oklahoma where natural gas is sold the rates to small consumers range from about fifteen to fifty cents per thousand feet while the rates to factories and other large users are often as low as three five eight or ten cents per thousand feet With thirty one kilowatt hours per thousand feet of natural gas at the rate of three cents the fuel cost amounts to less than one-tenth cent per kilowatt hour and even at the rate of ten cents per thousand feet the cost of gas is no more than one third cent per kilowatt hour where gas engines are used On the basis of the above conclusion that 26 600 cubic feet of natural gas will more than equal 2 000 pounds of steam coal under boilers the cost of this gas to replace the short ton of coal is $0 798 at the rate of three cents and $2 66 at ten cents per thousand feet

Where a central station is operating with a steam plant and coal for fuel, it may or may not be advisable to install gas engines for use with natural gas according to the price of the gas and the prospect of a permanent supply Even if the cost of natural gas used under boilers nearly equals that of coal the saving of labor in the fire room and the ability to instantly increase or decrease the gas heat may warrant its introduction

Of course an electric station has a legal right to as low a rate for natural gas as any other consumer of a like amount even though there is competition in lighting —Electrical Review and Western Electrician

THE VACUUM BOTTLE

WHY will the liquid in a vacuum bottle or in any other vessel remain cold three times as long as the same liquid will remain hot?

Power and the Engineer says the reason why can best be explained by a water analogy First perhaps a little study of relative temperature is necessary

If on a hot day with the mercury at 92 deg F a freezing liquid (32 deg F) be put into a vessel the liquid s temperature must rise 60 deg in order to reach the temperature of the surrounding atmosphere If on the other hand a boiling liquid (212 deg F) be placed in a vessel with the outside temperature at the freezing point (32 deg F) the liquid s temperature must drop 180 deg to reach the atmospheric temperature Thus a hot liquid on a cold day has three times the difference in temperature between itself and the surrounding air that a cold liquid has on a hot day

And now comes the application of the water comparison As every engineer knows or should know the pressure of water varies directly as the head Thus the pressure of a three foot column is three times as great as that of a one foot column Heat acts the same way The difference of 180 deg exerts three times the pressure or tendency to change that a temperature difference of 60 deg does Thus the 180-degree change will take place in one third the time required for the 60 degree change

It may also be well to remember that cold is merely an absence of heat Thus when a body becomes cooler the heat is leaving it and when it becomes warmer heat is entering it Also under equal conditions heat will enter or leave a body at identically the same rate of speed

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The rapid progress of aviation has caused attention to be drawn from a new direction to the dangers of atmospheric electricity In an article in the Elektrotechnische Zeitschrift Mr I Zehnder discusses the danger to balloons and aeroplanes of electrical disturbances and the methods of avoiding disastrous effects He points out that the electrical conditions of the air are subject to great variations during thunderstorms and that the atmospheric charges may change suddenly in sign In clear weather an ordinary balloon without metal parts is not exposed to any danger so long as it floats in the air but in the modern dirigibles much of the framework consists of conducting materials which add to the danger Also a balloon may be charged with electricity and a spark produced when contact with the ground is made setting fire to the gas.

ENGINEERING NOTES

Dakar is one of the few roadsteads on the West African coast which it has been found possible without prohibitive expense to convert into a port. It has of course natural advantages, such as its geographical position as a port of call for vessels running to South American and West African ports and the shelter afforded by the Cape Verde peninsula. To convert it into a port the works designed on the commercial side consisted of inclosing the harbor by two masonry moles, constructing two masonry piers each 32[illegible] yards long and [illegible]40 feet and [illegible] feet wide respectively, and quays connecting the piers, at a total length of 2,[illegible] yards, of which 78[illegible] yards have a depth of [illegible]6 feet and 1,4[illegible] yards a depth of over 2[illegible] feet alongside; reclaiming nearly [illegible] acres of ground behind the quays; dredging two basins, one to a depth of 26 feet and the other to a depth of over [illegible]1 feet (minimum depth at low springs); and lastly providing such accessory works as sheds, landing places, machinery and a water supply. The work was begun in 1904, and except for the installation of electric light and cranes it may now be regarded as practically completed.

In a recent paper Prof. W. H. Watkinson quoted the figures of Mr. Longridge as showing that gas engines are [illegible]0 per cent less liable to breakdowns than steam engines, these figures being obtained from trustworthy insurance data. The figures have so often been accepted as showing the superior reliability of the gas engine as compared with the steam engine, states a contemporary, that it seems necessary to point out that such a comparison is apt to be misleading. In the first place, the average size of the gas engines insured is usually considerably less than that of the steam engines, and the large gas engines are notoriously much less reliable than small ones. Indeed, the small gas engine is generally a very reliable machine and requires but little attention. Our best firms of gas engine makers put their highest efforts into these small machines. On the other hand, our contemporary maintains, the smaller steam engines are not usually so well designed or made, and they are so simple to run that as a rule they receive the scantiest of attention. As things are in practice, the small gas engine is probably more reliable than the small steam engine, but the reverse is probably true of large engines. That at least is the opinion of many insurance engineers.

A remarkable high-speed run of regular passenger trains is being made by the Great Western Railway of England in connection with transporting the passengers of the Cunard liners from Fishguard to London. The total distance from Fishguard to London is [illegible]61 miles, a distance which was covered on August 30th in [illegible]8 minutes by the special mail train and 2[illegible] minutes by a passenger train consisting of ten cars and weighing [illegible]4 tons. The first part of the run is a difficult one owing to heavy grades, including one over a mile in length of 1 in [illegible]0. The latter part of the run, however, presents more favorable conditions, and the run from Carmarthen to London, a distance of 230 miles, was made in [illegible]8 minutes, including a stop of four minutes. At one section 7[illegible] miles was actually covered in [illegible]0 minutes, and 100 miles were covered in [illegible]8 minutes 49 seconds, a remarkable performance with so heavy a load behind the tender. The locomotive pulling the train was a four-cylinder non-compound six-wheel coupled engine weighing 7[illegible]½ tons; cylinders 14¼ by [illegible] inches; working pressure 22[illegible] pounds, and with driving wheels 80½ inches in diameter.—Machinery.

As might be expected, papers read on traction subjects are very numerous in engineering proceedings, and as in this country the question of energy consumption on cars has come to the front. Quite recently a paper on the subject read apparently with the view of putting forward the claims of the mercury motor meter for this class of work produced an interesting discussion. Thus it appears that seven trips under test conditions on the loop and metropolitan sections of the West Side Company, Chicago, showed energy consumptions of 3[illegible] and 2.30 kilowatt hours per car mile respectively, using a 33-ton motor car and 1[illegible]-ton trailer. Seven carelessly driven trips showed energy consumptions of 4.29 and [illegible]0 kilowatt hours respectively. An average gain of [illegible] per cent in time and an excess of energy consumption of 26 per cent occurred in the last seven trips. The higher energy consumption on the loop was due to frequent stopping and starting. In view of the above, the operating efficiency of each motorman as regards power consumption will in future be entered on his record of service, a copy of each entry being sent to him. At Cleveland a series of tests of energy consumption on city and interurban cars, fourteen of each kind being tested, showed that while the interurban cars weighed [illegible] per cent more than the city cars, the energy consumption of the former averaged 3.75 kilowatt hours per car mile against 3.84 kilowatt hours in the latter [illegible]. This is equivalent to 88 watt hours per ton mile against [illegible] watt hours, the difference being due to the interurban [illegible] stops averaging fifteen against sixty-five in the [illegible] of the city cars.

SCIENCE NOTES.

According to a consular report dealing with the trade of Madagascar, the railway has reached Soanivana, 16[illegible] miles, whence motor cars and other vehicles take the passengers to Antananarivo, only 2¾ miles distant. The time taken from Tamatave to Tananarive is now two days, and when the railway reaches Tamatave from Brickaville the journey will be completed in one day.

Opening a discussion on positive electricity, Sir J. J. Thomson outlined the arguments which can be adduced in favor of the view that there is a natural unit of positive electricity analogous to the unit of negative which is known as an electron. The discussion which ensued brought out clearly that at present experimental knowledge is far too indefinite to warrant acceptance of any of the various views. Experiment is in favor of the recognition of fundamental differences in behavior between positive and negative electricity which are not adequately represented by a mere difference in sign, although some mathematical physicists are still conservative enough to retain the pre-Faradaic view; but beyond this it is not safe to go.

During the past year M. Salet, of the Paris Observatory, has been investigating the possibility of observing modifications in faint stars in full daylight. Many years ago the late Prof. Cornu demonstrated experimentally that blue sky light is strongly polarized; in pure air the proportion may attain as high a value as 80 per cent. Of course this applies only to the diffused or scattered light, which is simply sunlight reflected from the air particles. On the contrary, starlight, being intrinsic radiation proceeding direct from the celestial bodies outside our atmosphere, altogether is not polarized. Taking advantage of this fact, M. Salet places a Nicol prism before the eyepiece of the telescope; this acts as an analyzer on the polarized sky light, suppressing it from passing to the eye of the observer. The light from the star is allowed to pass with undiminished intensity, and therefore is relatively augmented in brightness from what it would be as seen without the Nicol prism. The arrangement has been tested on the meridian instrument at Paris, and it is stated that faint stars down to about the fifth magnitude have been satisfactorily observed at transit in full daylight.—Bulletin de la Société Astronomique de France.

The physicist who is also a mathematician possesses a most powerful instrument for scientific research, with which many of the greatest discoveries have been made; for example, electric waves were discovered by mathematics long before they were detected in the laboratory. He has also at his command a language clear, concise and universal, and there is no better way of detecting ambiguities and discrepancies in his ideas than by trying to express them in this language. Again, it often happens that we are not able to appreciate the full significance of some physical discovery until we have subjected it to mathematical treatment, when we find that the effect we have discovered involves other effects which have not been detected, and we are able by this means to duplicate the discovery. Thus James Thomson, starting from the fact that ice floats on water, showed that it follows by mathematics that ice can be melted and water prevented from freezing by pressure. This effect, which was at that time unknown, was afterward verified by his brother, Lord Kelvin. Multitudes of similar duplications of physical discoveries by mathematics could be quoted.

The theory (first enunciated by Clerk Maxwell) that light should exert a pressure upon any body on which it fell has been verified by Lebedew, Nichols and Hull. From the principle of equality of action and reaction it is evident that a back pressure must be exerted upon any body which is giving out light or radiation of any kind. Prof. Poynting, in a preliminary communication to the British Association at Winnipeg, described some first measurements made by himself and Mr. Guy Barlow of the pressure exerted. It would not be convenient to use an incandescent body for this purpose, owing to the disturbances that would arise. Instead, a thin slip of black or bright material is exposed to radiation, its temperature rises until the loss by radiation is equal to that which it receives. A perfectly black material will suffer the pressure due to the incident radiation and that alone, since it radiates equally on both sides—at least if it is thin enough to be sensibly affected at the same temperature on both sides. This pressure is equal to the density of the energy of the radiation E. A perfectly reflecting surface (such as silver approximates to) will experience a pressure equal to $2E$, since the beam of radiation is reversed by it, and again, there will be no other pressure in this case because no rise of temperature will take place. But if a metal film blackened on one side be taken with the black side toward the incident beam, there will be an extra pressure due to the inequality of the emission from the two sides. The measurements that have been made so far agree remarkably well with the expected values. Incidentally, these results give rise to the question as to how far the measurements made on the pressure of incident radiation are affected by a source of error arising from this cause. In the discussion which followed it appeared that Prof. Hull was alive to the possibility of an error, and his experiments had been carefully designed so as to exclude it.

TRADE NOTES AND FORMULÆ.

Etching Fluid for Glass (According to Reinitzer).—a. 1 000 parts water, 40 parts fluoride of sodium, 50 parts glacial vinegar. b. 1 000 parts water, 250 parts sodium fluoride, 160 to 170 parts hydrochloric acid, 200 parts sulphate of potassium. c. 1 000 parts water, 1 000 parts fluoride of ammonium, 200 parts sulphuric acid, 100 parts sulphate of ammonium. d. Solution of [illegible] parts crystallized soda in 5 parts of fuming fluorhydric acid; equal parts of this mixture to be mixed with equal parts of glacial vinegar.

Apple Ether.—Take 100 parts of highly rectified spirits of wine, 10 parts valerianate of amyl, 1 part acetate of ethyl, 2 parts aldehyde, 1 part nitrate of ethyl, 1 part chloroform, 1 part alcoholic saturated solution of oxalic acid, distilled in a glass retort. The first and last runnings are kept separate and only the middle distillate is used, which is rectified over finely cut fresh apple peels. First the ether with the apple peels should be left standing for 48 hours in a copper distilling apparatus lined on the inside.

To Etch Tin. The design is first drawn free hand with needle and pencil or traced with tracing paper and needle, the outlines filled in with a varnish (wax, rosin or asphalt). Same is made fluid by means of turpentine and applied with a brush. After drying, the article is placed in dilute nitric acid 1 : 3, taken out after 1½ to 2 hours, washed in water and dried with blotting paper. The asphalt coating is removed by heating and the tin oxide in the interstices cleaned out with the aid of silver soap and a brush.

Alloy for metal name plates is prepared by mixing 100 parts of pure molten copper consecutively with 6 parts of magnesium, [illegible]7 parts of sal ammoniac, 1[illegible] parts of unslaked lime and 9 parts of cream of tartar, all well pulverized, the whole continuously stirred; then 1[illegible] parts of zinc or tin are added in small pieces and stirred in until the whole is perfectly melted and mixed. The alloy is allowed to stand quiet on the fire for half an hour, the surface is then skimmed and the metal poured off.

Axle Grease.—Melt half a part of soda in 4 parts of water, add 3 parts tallow and 6 parts palm oil, heat to 1[illegible]8 deg. to 167 deg. F. and stir the resultant fluid until it has cooled to [illegible]8 deg. to 70 deg. F. An axle grease for high speed axles is made (1) from 1 part soap, 1 part rape oil, 5 parts water, 2 parts tallow powder; (2) brown osokerite, petroleum 4 parts. Allen's Excelsior axle grease is made from 1.1 part of linseed oil, 1.1 part castor oil, 1 part tallow, 1 part rosin, 0.5 part of ozokerite. If the grease is too hard, add a little neat's foot oil; if too soft, a little tallow.

To Stain Maple Wood a Dull Gray.—a. In a sufficiently large pitch-coated box place fine polishing sand, then the wood, and over this another layer of sand; pour rain water over all. Allow it to stand in a warm place for 3 to 5 weeks. b. Steep the wood for 3 to 4 hours in a decoction of gall nuts (1 part powdered gall nuts to 10 parts water), then allow it to lie for an hour in a solution of 1 part sulphate of iron (green vitriol) in 60 parts cold water; next brush it by means of a soft brush with alum solution (1 part of alum in 15 parts water) and allow to dry.

Maple Wine.—In spring, when the sap circulation begins to be active, bore into the trunk of a sugar maple about 20 inches above the ground, collect the juice that flows out and mix it with some fresh white wine that is still fermenting. After the maple sap and wine in vessels that must be kept in a place at a temperature of 68 deg. to 78 deg. F. has completed the chief fermentation, it is filtered, then add ½ a part of tartaric acid and 10 parts of sugar for each 1,000 parts, and rack into champagne bottles. These must be corked and kept lying down in a cellar. After six weeks the maple wine, which effervesces like champagne, is fit to drink.

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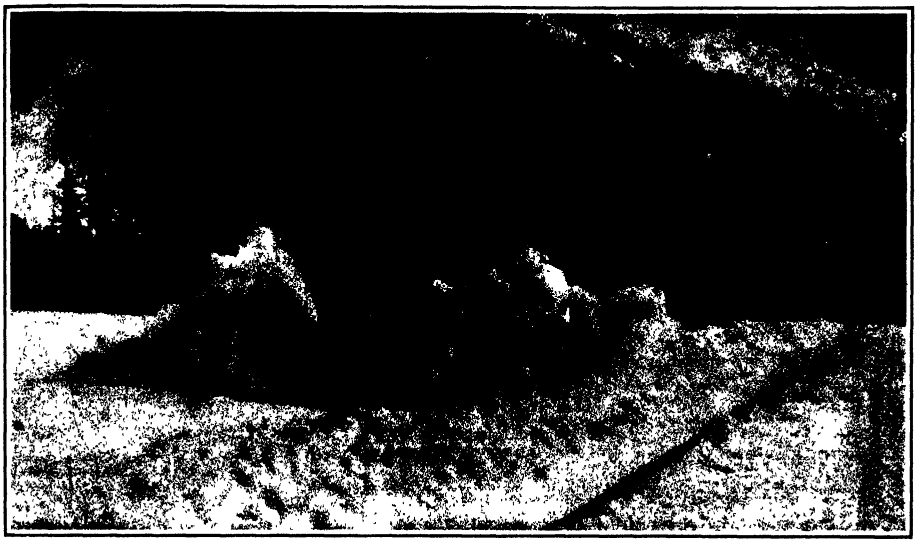

THE SNOW PLOW AT WORK.

THE SNOW PLOW OF THE FAYET-CHAMOUNIX RAILWAY.

A SNOW PLOW FOR AN ALPINE RAILWAY.

A SNOW PLOW FOR AN ALPINE RAILWAY.

AN INTERESTING ELECTRICAL LOCOMOTIVE.

BY DR. ALFRED GRADENWITZ.

Like many railways in the Swiss Alps the Fayet Chamounix electric railway was originally designed exclusively for summer service. Apart from the trifling amount of traffic to be expected the heavy snows in the Chamounix Valley and the difficulty of clearing the road proved obstacles to a winter service.

The constantly increasing traffic however eventually led the railway company to consider winter operation. It was therefore necessary to provide some means for clearing the track and obtaining a satisfactory electrical contact. The front cars were provided with contact shoes of special construction which could scrape ice and snow from the third rail. A powerful snow plow was designed to clear the road.

This snow plow is propelled by two motors similar to those of the ordinary motor cars which are of the quadruple pole type (with two consequent poles) the two exciting coils of each motor are mounted in series with the armature which is of the toothed drum type with undulated windings allowing only two brush sets to be used. The number of collector lamella is 11[illegible]. The inductor is of cast steel and constitutes a water tight frame consisting of two parts bolted to one another on a horizontal joint and completely surrounding the armature exciter coils collector and brushes. The latter are readily inspected through two windows in the upper half of the inductor. The lower half in which are located the armature bearings is provided with two cast on arms pivoted on the axle which to this effect is provided with an inside journal.

The two motors are invariably coupled in parallel and can be insulated from one another in cases of emergency by means of fuse interrupters located in a special box. They are suspended from the bogie by plate springs.

The motors are steered by a controller with magnetic blowing intended to effect the starting speed regulation stopping and reversing. The reversing is obtained by changing the direction of the current in the armatures the starting by the gradual cutting out of resistances inserted into the motor circuits and the speed regulation by shunting the inductors.

The controller may occupy eleven positions viz a central position corresponding with the dead point with which the motor feeding current is interrupted and five forward and five backward positions.

When the snow plow car travels separately the controller is actuated by hand with a removable handle by the motorman posted on one of the platforms. When however (which is the general case) the motor plow forms part of a train the controllers are actuated simultaneously from a distance by a motorman posted in the front compartment of the head car. To this effect each of the controllers is connected with a compressed air service motor fitted with two compressed air conduits serving for forward and backward traveling respectively. These two conduits terminate in the front compartment of the head car in an apparatus called the main service motor provided with a steering wheel.

In order to put the controllers of all the vehicles composing the train at the position desired the motorman has only to adjust the steering wheel of the main service motor to a corresponding position turning it from left to right in forward and from right to left, in backward traveling.

The four contact shoes are connected together by a system of joints and springs. They are of the same type as those used on the front cars for winter service and comprise steel plates with sharp edges pressed down on the third rail by a compressed air piston controlled by the motorman.

The snow plow proper has a triangular cross section with blades bent outward in a gentle curve so as to form in the lower part which comes in contact with the snow a sharply pointed blade inclined to the rail at a slight angle so as to offer a resistance as small as possible to any snow masses accumulated on the track. Trains of the following composition are formed for removing the snow:

(1) A snow plow car at the head of the train.

(2) A baggage car with motorman.

(3) A number of motor cars intended to increase the impact required for removing heavy snow masses.

These trains are able to remove snow layers upward of three feet and sometimes even six feet in thickness throwing them violently to right and left.

SUBMARINE SOUND SIGNALS.

A REVIEW OF PAST AND PRESENT ACHIEVEMENT.

The following information on submarine sound signals has been published by the United States Hydrographic Office under authority of the Secretary of the Navy.

Oversea traffic has exercised a powerful influence upon the advancement of civilization and the world wide benefits that flow from counteracting sources of delay and danger in oceanic voyaging has never ceased to prove a stimulus in the search for more definite and accurate aids to navigation. Most of the prominent points of those coasts to which commerce has spread throughout the world are marked with beacons by day and with lights by night but even if the time should have already arrived as doubtless it some day will when all the coasts of the United States had been defined from end to end by a band of light by night and by buoys and beacons prominently placed to be seen by day yet to a mariner encompassed in thick fogs all such guides and warnings would be of no avail. Fog obscures the characteristics of the most powerful light and blots out those marks which, when presented to the view serve to guide and to warn.

In many parts of the world especially in the Temperate Zones fogs frequently occur. On the eastern coasts of the United States and Canada an easterly wind is very often attended with fog. Between the Gulf Stream flowing northward in the Atlantic and the coast of the continent a current moves to the southward bringing to the shores of Canada and the United States water from the Arctic Zone. With an easterly wind air warmed and fully charged with moisture by contact with the Gulf Stream is blown across this cold current and the suspended vapor is chilled and frequently condensed in the form of fog. The embarrassment thus arising to shipping on the coast of America stimulated the people of the United States to be pioneers in the employment of sound signals for combating the adverse influences of foggy weather upon commerce and navigation for aside from the possibilities of wireless telegraphy the sense of hearing is the only means by which human perception may be apprised of the dangers lurking in coastal waters when the sense of sight is unavailable.

Until recent times the sound signals generally used to guide mariners especially during fogs were with certain modifications sirens trumpets steam whistles bell boats bell buoys whistling buoys rockets gongs bells struck by machinery and cannons fired by powder or gun cotton. In connection with all these implements the atmosphere is the medium of transmission of the sounds emitted from the sounding apparatus but it is a characteristic of the air that in contiguous spaces of the atmosphere the temperature humidity and pressure vary in such a manner as to produce a state which bears the same relation to sound as cloudiness does to light. Tyndall has thus described these conditions. By streams of air differently heated or saturated in different degrees with aqueous vapors the atmosphere is rendered flocculent to sound. Acoustic clouds in fact are incessantly floating by through the air. They have nothing whatever to do with the ordinary clouds fogs or haze and the most transparent atmosphere may be filled with them converting days of extraordinary optical transparency into days of equally extraordinary acoustic opacity.

THE INADEQUACY OF AERIAL SOUND SIGNALS

The mariner has long since learned to be exceedingly cautious about depending upon aerial sound signals even when near. Experience has taught him that he should not assume that he is out of hearing distance of the position of the signal station because he fails to hear its sound that he should not assume that because he hears a fog signal faintly he is at a great distance from it nor that he is near because he hears the sound plainly that he should not assume that he has reached a given point on his course because he hears the fog signal at the same intensity that he did when formerly at that point neither should he assume that he has not reached this point because he fails to hear the fog signal as loudly as before or because he does not hear it at all, and that he should not assume that the fog signal has ceased sounding because he fails to hear it, even when within easy earshot.

While both the range and the certainty of the transmission of sounds through the air may be enhanced by imparting such excessive energy to the sound waves as to render them less liable to the dissipating influences of a variable atmosphere yet with the fog signals heretofore in use, it has been impossible to distinguish by any means available to the mariner at sea, the times when he might expect aberrations in audition from the times when the sounds would be heard normally as to force and place.

THE SUPERIORITY OF WATER AS A MEDIUM FOR THE TRANSMISSION OF SOUNDS AT SEA

Water is less a mobile medium than air less responsive to marked variations of density arising through changes in temperature and pressure, and, therefore less subject to variations of homogeneity and more reliable as an agency of the transmission of sound waves. In his experiments on Lake Geneva in 1826 Colladon had a bell weighing about 150 pounds suspended some 5 feet under water from the side of a boat and struck by a hammer attached to the end of a lever. Stationed in another boat he listened for the bell sounds propagated beneath the surface which were conveyed from the water by a cylindrical tube of tin some 9 feet long and 6 inches in diameter. One end of this tube terminated in an orifice for insertion in the ear and the other was spread out somewhat in the form of a spoon with its orifice closed by a flat elliptical plate of tin about 2 square feet in area. By attaching a suitable weight to the lower end of the tube it was easily retained in a vertical position with about four fifths of its length submerged its flat plate being turned toward the boat carrying the bell. With this simple apparatus Colladon was able to hear, with perfect distinctness the blows of the hammer on the bell across the widest part of Lake Geneva, when the calculated distance between the two boats was not less than 8 miles. The sounds which he heard appeared as if they had been caused by some metallic body striking the bottom of the tube and they were as distinct at 8 miles as at a few hundred feet from the bell. One set of observations was made during a strong wind. The waters of the lake which were at first calm became violently agitated, and it was necessary to keep the boat in position by means of several anchors yet, notwithstanding the noise of the waves that struck the tube he took observations with the same accuracy as when the air and water were still. And he states "I am convinced that by employing a bigger bell, and improving or enlarging the hearing apparatus, easy communication could be effected under the water of a lake or of the sea, up to 15 or 20 leagues."

Plans for making a practical use of the water as a means of communication between vessels at sea commenced to germinate with the invention of the telephone in the latter part of the last century.

In his admirable work, entitled 'The Modern Light-House Service,' published as Senate Executive Document No. 56, Fifty-first Congress, first session, Mr. Arnold B. Johnson, chief clerk of the United States Light House Board has made reference to the experiments which were commenced in 1883 by Prof. Lucien Blake whose plan is described as follows: "A sound producing apparatus was to be attached to each vessel, and to be worked under the surface of the water. In times of fog or at night a code of signals would be produced by it which would be transmitted in all directions through the water with a velocity four or five times that in the air Each vessel, in addition to the sound-producing apparatus, would be provided with sound-receiving apparatus, which would take up out of the water the signals arriving from the neighboring vessels For steamships the sound producing apparatus was designed to be a steam fog horn or whistle, especially constructed to sound under water, and to be heard at least from 6 to 8 miles

As to the receiving apparatus with which each vessel was to be provided, the original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel"

SUBMARINE SIGNAL BELLS.

It is along these general lines that the problem has been so successfully solved under the auspices of the Submarine Signal Company, of Boston, that the method of submarine sound signaling has been officially recognized as supplying an important aid in navigation. As early as 1903 the United States Light House Establishment had furnished the light vessels at Boston, Nantucket, Fire Island, and Sandy Hook, with submarine fog bells The equipment consisted of a bell with striking mechanism actuated by compressed air, suspended at a depth of 30 feet or so beneath the surface of the sea from a davit at the side of the vessel, a small and compact air compressor driven by a kerosene engine or by steam from the boilers of the lightvessel, for the purpose of furnishing power to operate the bell, and a code ringer also connected with the compressor engine, and adapted automatically to control the strokes of the bell so as to cause its ringing to send out the code number of the lightvessel

The sound waves going out from the lightvessels below the surface of the sea could be heard for a distance of some miles by passing ships equipped with microphones to receive submarine sound signals These sound receivers are located inside the hulls of ships below the water line, and connected with the chart room or bridge by a telephone circuit On either side of the forehold there is fitted a small tank on the inside of the skin of the ship without cutting the plating or making any alteration whatever in the hull of the vessel A small opening in the top permits the introduction into the tank of a dense liquid in which the receiving microphones are suspended By listening at the telephone, whose circuit includes both the port and starboard microphones, and switching the instrument from the starboard to the port microphone and back again, the tones of the lightvessel's submarine bell could be heard on coming in range of it If the tone was louder on the starboard side than on the port, the mariner would know that the lightvessel was on his starboard side, and if the tone was exactly the same in both microphones, he would know that the lightvessel was dead ahead.

It was found that even in the case of vessels to which the sound-receiving microphones had not been fitted, a listener, putting his ear to the inner surface of the plating, say in the empty forepeak below the water line, could hear the sound proceeding from a submarine bell several miles away, but under such circumstances no information is derived as to the direction from which the sound proceeds, and hence a vessel encompassed in fog could not be steered by bell, and must suffer a denial of those advantages that come from the knowledge of direction that is derivable on board of vessels in which suitable instruments have been installed to receive the sounds

The substantial service rendered to shipping by the submarine bells first established decided the United States Lighthouse Board to extend their installation, from time to time, to other lightvessels until, at present, 46 of the lightvessels in the waters of the United States are thus equipped, and the signals which they send out are of undoubted aid to deep water navigation

Equally effective as aids to navigation are the submarine bells that have been fitted to buoys, where they are worked by the motion of the sea, and those that have been suspended from tripods on the sea bottom, where they are controlled electrically from shore stations and serve to give warning of dangers or to make turning points along the routes of commerce.

Many of the lightvessels and buoys of European waters have been similarly furnished with these bells, and they have been likewise established in the region of the Gulf of St. Lawrence; and, as the effective range of the submarine bell far exceeds that of aerial sound signals, having been known to exceed fifteen miles, and their bearing can be determined with sufficient accuracy for safe navigation in fog, if a vessel is equipped with receivers, it has seemed appropriate to set forth for the benefit of mariners a list of stations where they are at present established.

Remarkable endurance tests have been applied to some of these submarine signaling installations. From a cottage at Point Allerton, near Boston, in which a 2½-horse-power oil engine operated an electric generator, a submarine cable was laid to the shore, and thence 2 miles out into the harbor along the sea bottom At the end of the cable was an iron tripod standing on the bottom of the ocean, 70 feet below the surface of the water, and on the tripod was a bell weighing 220 pounds, the clapper of which was actuated by powerful magnets On March 30th, 1907, the current was turned on, and the bell began to strike at the rate of about 22 blows a minute, and continued until the 16th of May when the total number of strokes had reached 1,032,930 in a duration of 789¼ hours

The pneumatic bells on five lightvessels were also required to be rung continuously, night and day, for sixty-one days, making a period equal to two and a half years of service according to the highest demands made in past years upon the fog whistle on the light vessel at Sandy Hook Submarine bell buoys have also been tested. The fact that the bearing of the buoy can be found in fog or at night makes them advantageous to shipping when they are placed in exposed positions in water of sufficient depth to give the vessel steering for them sufficient space to maneuver for the purpose of locating the origin of the sound It is noted that in restricted waters, or when the bell is located near steep banks or rocky shores, an echo may be expected, and this fact requires that the proposed location should, in each case, be thoroughly investigated by experiment, because there are possible situations where the echo may be heard instead of the direct sound, and thus lead to an erroneous determination of the place of the danger which the bell is intended to mark

The mechanism for submarine bell buoys is dependent on wave motion for its power, and therefore, differs from that of the electrically controlled tripod bell and also from the pneumatic bell employed in connection with lightvessels On the trunk or stem of the buoy is a float or 'sea anchor' free to move up or down for a short distance and ballasted so as to have, as nearly as may be the same weight as sea water It is the design that this shall remain practically stationary as the buoy rises and falls The pull rod of the clapper is connected to a crank on a toothed wheel which is turned by a ratchet and pawl gear operated by two arms attached to the sea anchor Of special interest in connection with submarine signal buoys are the gas buoys which have been experimentally fitted with bells that are rung through mechanism actuated by the pressure of the gas supplied for the light, and are thus independent of the action of the waves as an agency for ringing the bell, and consequently free of the liability to irregularity in the intervals between the strokes of the clapper which precludes the successful ringing of a code signal

COMMUNICATION BETWEEN VESSELS AT SEA

Beside their usefulness in warning vessels of their approach to the land and to dangers submarine sound signals may be used as a means of communication between vessels at sea For this purpose the sound producing bell, immersed in water held in a tank, is installed, in the fore peak of the vessel inside of the hull, and may be operated automatically or by hand. As a means of communication between submarine boats in a state of submergence, this method of signaling has a special field of utility During the tests of submarine boats in May, 1907, communication was, in this manner, kept up between the 'Octopus" and the tender "Starling" Signals were communicated from the 'Starling" to the 'Octopus," telling when the latter had crossed the finish lines, and when to come to the surface, and distinct messages were received in return from the submerged vessel

THE EQUIPPING OF VESSELS WITH SUBMARINE SOUND RECEIVERS.

The maritime community has availed itself more and more of the facilities which have thus been provided by the fostering care of various governments with a view of lessening danger in navigation and delay in transportation and an increasing number of vessels have, year by year, been furnished with submarine sound receivers, and, for the convenience of underwriters in determining rates of insurance, the American Bureau of Shipping has noted in 'The Record of American and Foreign Shipping," which of the vessels are so equipped.

The saving of time brought about by enabling vessels to reach port instead of being delayed by fog and losing tides is being constantly exemplified The "Lucania," while approaching New York on one occasion made all three lightvessels by submarine-bell sounds, which constituted the sole guide, and we read in the Cologne Gazette that the captain of the 'Kaiser Wilhelm der Grosse," during the course of a voyage to New York, when surrounded by a dense fog off the coast near Fire Island lightvessel, heard the submarine bell and was able to steer by it, when, as it subsequently transpired, he was twelve nautical miles distant from the signal station. At 6·45 A M the sound of the bell was heard to starboard, and, owing to the fog, the ship, which was some distance out of her position, was guided solely by these bell signals, and the course was altered by the sounds heard from the light ship, though the fog horn was wholly inaudible

THE RANGE OF AUDIBILITY OF SUBMARINE BELLS

While careful listening at the telephone is always a requirement that must not be underrated nor overlooked, it is found that vessels of deep immersion have an advantage in the range of distance at which submarine sound signals may be detected and this is accentuated in cases where they are moving at a slow rate of speed Indeed on the Great Lakes, where the forepeaks of vessels are frequently above the water line, special provision was necessary for the proper submergence of the tanks containing the sound receivers

There appears to be no failure to hear and recognize the sounds of the submarine signal bells at distances between three and five miles and on the average these distances are considerably exceeded

What range of submarine transmission of sound waves will ultimately be set as the limit of practical audibility of such signal bells is not now known, but the possibility of a comparatively extended range under special conditions, is foreshadowed in the observations that have been lately made between the lightvessel 'Gabelsflasch," located at the entrance to Kiel, Germany, and the lightvessel "Fehmarnbelt," situated nearly twenty seven nautical miles away On different occasions the ringing of the submarine bell on the latter lightvessel was heard by the unaided ear through the naked walls of the carpenter's store room on the 'Gabelsflasch" vessel Without doubt this remarkable transmission was favored by the form of the sea bottom, which, while not of an even depth in the region between the lightvessels, does not suffer any sudden or great irregularities, and perhaps, the energy of the sound waves freed of interference by the infrequency of traffic in midwinter and by the absence of agitation of the waters from storm was conserved and strengthened by the narrowing shape of the borders of this portion of the German sea

Although there are some situations in which the submarine sound signals are cut off as for example, when an underwater formation, like a bank or shoal, rises from the bottom and culminates near the surface of the sea these observations on the "Gabelsflasch" vessel indicate that conditions may be found or arranged which will be exceptionally favorable for the distant transmission of signals Thus where there is a funnel-shaped entrance bounded by jetties running far out into the sea, it may be practicable, by the concentration of waves from an origin of sound placed near the vertex of the funnel, to mark out a sharply defined sound sector for the purpose of locating the entrance when it is obscured by fog or darkness.

LUBRICATION UNDER PRESSURE.

LUBRICATION under pressure has been applied with success to dynamos, turbines, internal combustion motors and other high speed machines and within the last three years it has been applied to the great marine engines of British warships About 1 gallon of oil is used per hundred horse power per day of 24 hours and, as part of the oil can be recovered and used again, the process is very economical The apparatus used for dynamos and small motors consists of a single oil pump operated by an eccentric The apparatus employed in the British navy usually includes for each engine three oil pumps driven by steam an oil tank and a vessel for the separation of oil from the water of condensation, in addition to the necessary pipes and filters, and a collector for exuding oil In order to prevent rapid clogging of the conduits it is necessary to use a non saponifiable oil, free from resin

As the dimensions of ships are being continually increased, for the purpose of augmenting either speed or carrying capacity the ports, docks, and channels of the world are becoming insufficient for the demands made upon them Hence shipbuilders are compelled to remain within certain limits of length, breadth and, especially, draft The result is that the new vessels do not possess the requisite stability and displacement and that shipping companies complain that they are unable to make full use of their costly equipment Many ports, docks, and basins are being improved and enlarged, but these great works designed in accordance with the dimensions of the largest vessels now afloat, are not yet finished and the dimensions of newer ships are increasing in unforeseen proportions The "Umbria," built in 1883, had a length of 502 feet, a draft of 27 feet, and a speed of 17 knots, the "Mauretania," built in 1907, has a length of 790 feet, a draft of 37 feet, and a speed of 26 knots Here the length has increased 57 per cent, but the draft only 37 per cent Yet upon the draft depend the stability, the harmony of form, and the capacity of the vessel Hence the enlargement of ports and docks is loudly demanded, but how shall the work be planned when the dimensions of future ships cannot be foreseen?

FRICTION DRUMS AND BRAKES.*

HOISTING-ENGINE ESSENTIALS.

BY WARREN O. ROGERS.

In hoisting-engine practice two of the important parts which must operate with certainty at all times are the friction drum and brake When very heavy material is being hoisted the engineer and all others concerned with the work want to be sure that the brake on the hoisting drum is going to hold when it is applied In order that he may know that the brake and friction drum are in working order it is advisable for the operating engineer to become familiar with the construction of various types

In Fig 1 is shown a friction drum which consists of blocks of seasoned hard wood fitted and secured to a projecting rim on the gear wheel On the drum flange is cast a rim having a beveled surface on the inner side to correspond to the bevel of the wood pieces with which it engages when thrown into contact

The drum is fitted to turn freely on the shaft and also have a slight lateral movement on the drum shaft sufficient to make contact on the friction drum with enough force to hold the strain of any load the engine can hoist The drum is moved by means of a lever attached to a screw which makes contact when thrown into gear with a steel pin two steel plates and one of bronze the latter being placed inside the friction nut These plates are in oil receptacles which should be filled with lubricating oil

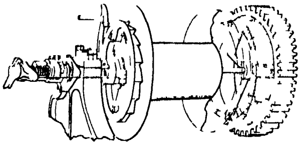
Fig 1 FLORY FRICTION DRUM

The movement to release the friction is effected by connecting the end of the friction screw to the drum by means of a rod and yokes which by a reverse movement of the friction lever will positively disengage the friction under all circumstances As an auxiliary a recoil spring is placed on the shaft between the gear wheel and the drum the pressure of which against the drum produces a gradual release This friction drum is used on the hoisting engines made by the S Flory Manufacturing Company

Another type of friction drum is shown in Fig 2 It is lagged with either wood or mineralized leather The spur wheel which carries one member of the friction is keyed against a shoulder upon the drum shaft At the opposite end of the shaft is a collar threaded and secured to the shaft by a set screw the end thrust when applying the friction being taken by the collar A flange sleeve having an external thread of coarse pitch is placed between the collar and the drum hub the flange and the sleeve having a number of holes spaced on a concentric circle Through one of these hubs a screw passes and screws into the side frame to prevent the sleeve from rotating The wear on the friction is adjusted by turning the sleeve in the proper direction a sufficient amount and the sleeve is then secured by means of the bolt placed in a hole in the frame that coincides with the hole in the flange

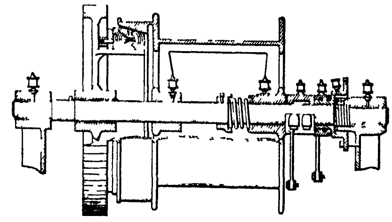
Fig 2 EXETER FRICTION DRUM

On the sleeve is a hub with a lever for rotation When rotated in one direction the friction is applied rotated in the other direction the friction is released by the recoil spring A loose fitting stationary hub is placed between the operating sleeve and drum hub and is provided with an extending arm to prevent rotation This stationary hub is made in halves so as to be removable for relagging the friction if necessary This friction drum is made by the Exeter Machine Works

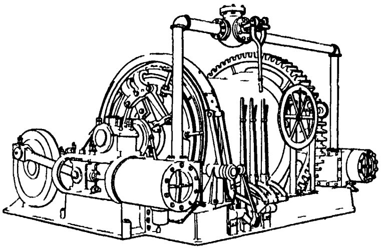
Fig 4—APPLICATION OF BAND FRICTION TO DRUM

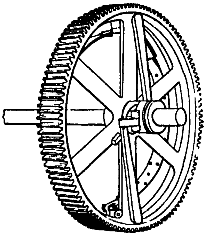
Fig 6—ANOTHER VIEW OF THE DENVER CLUTCH

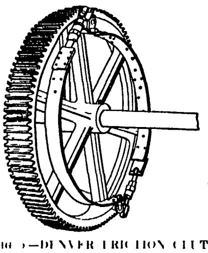
Fig 5—DENVER FRICTION CLUTCH

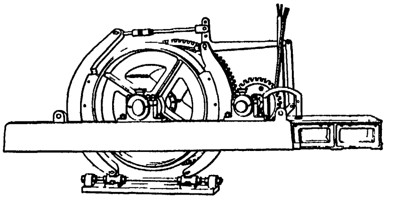
Fig 7—ONE TYPE OF POST BRAKE

Another type of friction or clutch is shown in Fig 3 The clutch runs loosely on the drum and is fitted with a band friction clutch consisting of a disk keyed to the shaft which is fitted with two arms carrying a steel band lined with removable bass wood blocks and having a suitable means of adjusting the friction band by means of bolt and nut as shown One arm is bolted to the disk and the other fulcrumed from it and receives its motion from a combination toggle connection and rockshaft which is operated by a hand lever In this type of friction the clutch is locked in either the on or off position and end thrust of the shaft is eliminated

Fig 4 shows the application of the friction which is fitted to the hoist put out by the Wellman Seaver Morgan Company The illustration also shows the band brake which is operated by an independent hand lever The band is attached at one end to the foundation and at the other to the hand lever the connection being such that a continuously increasing force is applied to the brake while the operator pulls with uniform strength on the lever

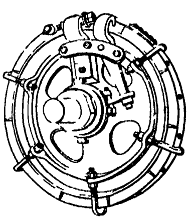
Fig 3—BAND FRICTION CLUTCH

Another type of friction clutch is shown in Figs 5 and 6 which show both sides as it appears when applied to a gear wheel It consists of two steel bands lined with a special material to take up the wear instead of having it come on the steel bands These bands encircle the clutch drum which is made a trifle smaller in diameter The ends of the clutch band are connected to a pair of bell cranks mounted on the rockshaft which passes through bosses cast on the rim of the main drum gear as shown On the opposite ends of each rockshaft carrying the bell crank is forged a lever arm that reaches to opposite sides of the gear hub and shaft in Fig 6 These arms are connected by means of rings to the clutch sleeves that slide on the drum shaft On the outer end of the sleeve is a groove which engages the clutch fork and is in turn operated by the clutch lever at the operator's stand As the clutch sleeve is moved toward the gear the link forces the ends of the long lever outward which actuates the bell crank so as to draw all four ends of the clutch band together This clutch is self locking whether open or closed

In Fig 7 is shown a type of post brake consisting of two beams placed vertically each partially encircling the brake ring on opposite sides The beams carry a large wooden wearing block the side next to the brake rim conforming to a circle Both brakes are controlled by hand levers The types of brake shown in Figs 5, 6 and 7 are made by the Denver Engineering Company

A cork insert friction is illustrated in Fig 8, and is made by the Lidgerwood Manufacturing Company The gear wheel of the drum is fitted with a friction flange as shown, in which are fitted cork inserts which are allowed to project about 1/32 inch above the wooden flange rim and although contrary to what one would suppose as the wood of the friction wears away the cork retains its original amount of projection the wear seemingly being proportional As cork will not burn as readily as wood and does not slip as easily the cork is very durable Another feature is that oil does not affect its holding power, and trouble from slipping is practically eliminated even though oil should get on the friction drum

In Fig 9 is shown the design of the friction pin used for this type of friction drum It consists of a coarse pitch screw to which is attached the lever for operating it The screw when turning comes in contact with a friction pin which is placed in an oil box and being submerged in oil eliminates what would be serious friction losses, as well as any possibility of the pin and screw becoming welded due to dirt and friction As the oil box is inclosed foreign matter is prevented from getting into the oil and the pin and screw are kept clean at the same time sufficient lubrication is always provided

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* Power and the Engineer

A friction of the double V type is shown in Fig 10, and is made by the Clide Iron Works It is composed of long segments of hardwood bolted to the spur wheel and turned to fit the faced friction surfaces in the drum flange with which they engage when in gear These friction blocks are arranged with the grain radial and present a large area of friction surface across the grain Owing to the angle of the friction and friction block a very slight movement of the drum along the shaft is sufficient to engage it which makes it a positive and powerful friction

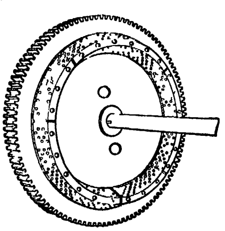

FIG 8—CORK INSERT FRICTION

The friction engagement is accomplished by means of a forged steel lever friction screw and nut placed at the end of the drum shaft between the drum and motion to the drum by means of a tool steel pin crosskey and collar This friction arrangement is so efficient that a very slight pressure on the lever is sufficient to hold the drum in gear against any load the engine may handle

The release of the friction is automatic when the pressure is removed due to the heavy steel spiral spring which encircles the drum shaft between the drum and gear wheel and the end pressure against the thrust members exerted by this spring is relieved when the drum is thrown off The spring is confined by a steel check bolted to the gear wheel to allow for adjustment when needed This spring check device removes all resistance to free unwinding of the drum and at the same time prevents the spring from exerting a pressure on the thrust member

In Fig 11 is shown an outline drawing of an Otto gasoline mining hoist The thrust collar which takes up the thrust when the friction clutch is thrown in is screwed to the drum shaft The friction surfaces are inclosed in a box filled with oil or grease which protects them from dust and dirt

The brake is of the differential type and the load tends to tighten it after it has been applied The brake bands are lined with blocks of hardwood and are made in two sections joined by a bolt with nuts to adjust for wear

The load is hoisted by throwing the drum in gear and lowered by applying the band brake As shown the operating levers are mounted in a rack and so arranged that the operator faces the shaft The clutch lever is connected to a speed changing device the speed of the engine being automatically reduced when the hoist is not in actual operation or when the load is being lowered

MODERN MARINE BOILERS

The survival of the fittest is abundantly manifested by the Scotch boiler which after passing through many vicissitudes is still the most popular with the ship owner That it has given place to a large extent to Babcock and Yarrow boilers in warships is in nowise remarkable because conditions of working and upkeep prevail in the navy which are very different from those obtaining in the mercantile marine But it must not be forgotten that its success alike in our greatest Atlantic liners and our smallest ocean tramps is mainly due to causes which are not closely concerned with the general design of the boiler

It is clear that the workmanship and material of a boiler have next to nothing to do with its evaporative efficiency So long as the boiler does not leak a square foot of heating surface is just as good other things being equal, in a weak badly made boiler as it would be in a boiler of the best possible construction This means, in other words, that the Scotch or return-flue marine boiler found its way to the hearts of the shipowners while pressures were very low plates thin and small, and workmanship poor when judged by modern standards As time went on safety valve loads augmented, and it was argued that only the water-tube or locomotive boiler could stand the stresses. But shell plates were rolled at moderate prices, daily larger and thicker and this more rapidly than pressures rose Then it was said that although shells might comply with the conditions, furnace tubes could not The answer to that was the corrugated flue In one word the steel manufacturers were able to supply plates and the boilermaker to use them in a way which met any possible demand for high pressure The notable fact is that the design of the boiler lent itself easily to the utilization of thick plates just as

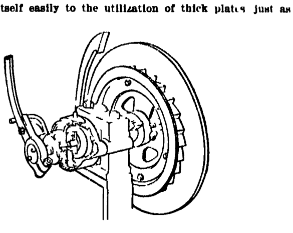

FIG 9—LIDGERWOOD FRICTION PIN

well as it did to the utilization of thin plates We are prone to forget nowadays the importance of the part played by good workmanship and good material in perpetuating types which must have become obsolete without them Every advance that has taken place in the economical production of power at sea has been in the first place due to an increase of pressure While the pressure remained at 0 pounds nothing whatever was gained by compounding The introduction of a second cylinder had no effect unless to augment the weight of steam required per horse power hour In

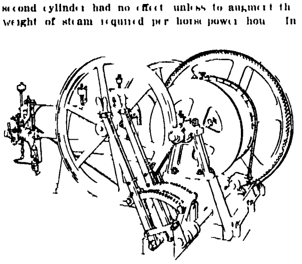

FIG 11—DRUM AND BRAKE OF OTTO GAS ENGINE HOIST

like manner triple expansion with [illegible] pounds to 80 pounds steam meant waste The presumed effect of reduction of range of temperature in each cylinder had no existence The pressure jumped to 130 pounds and 150 pounds and lastly to 160 pounds Now we have quadruple expansion but to make it pay the pressure is 200 to 220 pounds and these last enormous pressures are carried with perfect safety in gigantic boilers still of the Scotch type The thing would be wholly impossible were it not for the improvements which have been made in rolling mills and in the machinery of our boiler yards Twenty five years ago no one would have dreamed of designing a Scotch boiler 15 feet in diameter with shell plates 2 inches thick

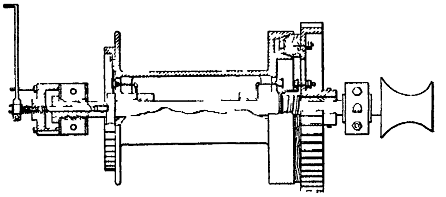

FIG 10—CLIDE V TYPE FRICTION CLUTCH

Modern plant has rendered the manufacture of such boilers a matter of certainty and that on a perfectly satisfactory commercial basis We are very liable when criticising our predecessors to forget that much that was known to them to be desirable was also known to be impossible

Nor is the end even yet in sight Lloyd's and the Board of Trade used to stipulate that no steel over ’8 tons or under 26 tons should be used in a boiler These rates were modified and now Lloyd's no longer stipulate for anything save that their engineer surveyors shall be satisfied It is by no means impossible that 60 ton steel may be used at no distant period It is now we may say simply a question of price But inasmuch as the weight of a boiler made of high steel would be little more than 60 per cent of that of a boiler made of low steel there is it will be seen, a considerable margin available As far as mere saving in weight is concerned however it is doubtful if the owner of large ships would attach any particular importance to it

It is clear that the closing of 1¾ inch rivets is quite beyond the power of manual labor It follows that but for the riveting machine we should have no thick boiler shells At every turn indeed we have the interdependence of the arts brought before us The facts are put very much in evidence by a few passages contained in an excellent practical paper on Marine Boiler Design Construction and Economy read before the North East Coast Institution of Engineers and Shipbuilders on the 29th of October by Mr D Myles After referring to the time when ship riveters and caulkers were employed in making boilers when they were not wanted on the ships a practice now quite out of date he went on Along with the improvement in workmanship there have been vast improvements made in machines used in the manufacture of boilers The holes for stay tubes which a few years ago were tapped by hand are now almost universally accurately tapped by machine and this applies also to stay holes between combustion chambers boiler backs etc and a hole tapped by machine is more likely to be true and fair than one tapped by a man pulling at the end of a long single ended lever as was frequently the case in former years and if the hole is truer the screwed stay will necessarily be a better fit One result of all this is that the only limit to the size of a boiler is economy in working Double ended boilers carrying 190 pounds and weighing over 100 tons are in use and giving much satisfaction The weak point about these heavy boilers is the calking No method of welding is trustworthy but it would not seem to be impossible to devise some method of electrical or blow pipe welding by which the edge of one plate might be fused autogenously if we may use the word on the surface of the other riveting having of course first been done in the usual way

One fact we commend to the attention of those who believe that reduction in the size of a boiler is a highly desirable prize Mr Myles points out that the whole modern tendency is to make boilers larger instead of smaller Thus combustion chambers are made much deeper than they were with great benefit and more room is left between the shell and the tubes Nothing has struck him more forcibly than the great change of opinion and practice with regard to crowding a large amount of heating surface into the smallest possible boiler thereby reducing the space for cleaning and examination and otherwise making the boiler unsatisfactory Boilers which a few years ago were considered large enough to contain about 2 400 square feet of heating surface are now usually made 9 inches or 12 inches larger in diameter This extra size is due to a large number of causes the principal of which are the larger spaces between combustion chambers between nests of tubes and between steam space stays thereby making the boiler much more accessible for cleaning and as ships engineers together with boiler cleaners are very human the boiler that is not easily accessible is very liable to go improperly cleaned and the opposite of course also holds good that a boiler easily accessible is much more likely to be thoroughly cleaned and in boiler treatment cleanliness is of the very highest importance if long life and satisfactory results are to be obtained It is frequently forgotten by professional boiler designers and always forgotten by amateur designers that much more has to be kept in view than the combustion of coal and the making of steam Apparently small matters may make a great difference No mistake is more common or more harmful than the crowding of too many tubes into a shell Boilers have this in common with animals that they must have room to breathe —The Engineer

INDUSTRIAL ELECTROLYSIS.

THE EMPLOYMENT OF ELECTROLYSIS IN CHEMICAL MANUFACTURE.

BY PROF. B. LEPSIUS.

Although electrolysis was introduced into manufacturing chemistry in the eighties the chief chemist of the English United Alkali Company in 1888 pronounced the electrolytic production of soda chimerical. This may be the reason why this method was not sooner employed in England but it is not surprising that the industrial electrolysis of alkaline chlorides was first developed in Germany which surpasses all other countries in deposits of rock salt and potassium chloride. The first impulse was given by a process patented by Hoeptner in 1881 which however soon proved impracticable.

According to the chemical formula a solution of sodium chloride (common salt) when electrolyzed should yield sodium hydrate (caustic soda) and hydrogen at the cathode and chlorine at the anode but the reactions which take place at the electrodes were then little understood.

It was evident from the beginning that such staples as soda and chloride of lime could not be produced with profit on a small scale but the employment of electrolysis which is proportional to the area of the electrodes and cannot be effected economically with any but an exceedingly small current density necessitated great enlargement of the already extensive plants. In order to make the apparatus as compact as possible vertical electrodes and porous diaphragms were employed. Breuer devised a diaphragm of cement impregnated with salt and hydrochloric acid which after some improvement proved sufficiently resistant to the action of chlorine and alkalies. Iron and carbon appeared to be the most suitable materials for the cathode and the anode respectively. It was found however that the water of the solution was electrolyzed with increasing rapidity as the process continued and that the oxygen thus liberated gradually consumed the carbon anodes producing carbon dioxide which became mixed with the chlorine. For this reason anodes of oxide of iron have lately come into use. These anodes are good conductors and last indefinitely as they are not attacked by the oxygen which at the high temperature of the bath (160 170 deg. F.) converts some of the sodium chloride into chlorate which crystallizes in the anode compartment and is removed from time to time. Thus a valuable by-product is produced instead of the annoying carbon dioxide.

When the liquid surrounding the cathode has attained a certain degree of alkalinity the circuit is broken and the alkaline liquid is drawn off and replaced by fresh chloride solution. The liquid in the anode compartment is not changed. The alkaline liquor is concentrated to half its volume in vacuum pans. Nearly all of the chloride which has not been decomposed is precipitated during this operation and is used again.

The first electrolytic plant established in Griesheim was operated with 100 horse power. The capacity was doubled in 1892 and a factory employing 2 000 horse power was started soon afterward. At the same time a 00 horse power plant was installed at Bitterfeld. The Griesheim company also established a factory in France and one in Spain the latter being operated by water power. The Baden aniline and soda company adopted the Griesheim process which yielded chlorine and caustic soda both of which were used in the production of artificial indigo. Another German and a Russian soda factory employ the same process.

Meanwhile the Elektron company which owned Hoeptner's first patent had consolidated with the Griesheim company forming the Griesheim Elektron Company with a capital of $[illegible]0 000.

In 1894 a 000 horse power plant for the electrolysis of alkaline chlorides by the Rathenau process was built at Bitterfeld by the Allgemeine Elektrizitaets Gesellschaft which subsequently established a 3500 horse power plant in Baden. The Griesheim process is now employed in factories with an aggregate consumption of 33 000 horse power corresponding to a total annual production of 50 000 tons of caustic soda and 1 0 000 tons of chloride of lime.

This is not the only method by which the problem of electrolysis has been solved but the mercury processes of Castner Kellner and Solvay and the Austrian Bell process were not successfully employed until 1897 and 1901 respectively seven and eleven years later than the Griesheim process.

In all diaphragm processes the waste of current caused by the gradual accumulation of alkali makes it necessary to stop the operation before the alkaline solution has acquired great concentration. This defect led an American H. Y. Castner to suppress the diaphragm and use a cathode of mercury which immediately amalgamates with the sodium liberated by electrolysis and prevents the decomposition of water. The accumulation of sodium at the cathode is prevented by causing the liquid amalgam to escape as it is formed to another compartment where it is decomposed by water. Similar processes were devised by the Austrian Kellner and the Belgian Solvay and all three mercury processes are now owned by the Castner Kellner Alkali Company which was organized in 1895 with a capital of $1 00 000. This company and affiliated companies in Europe employ more than 6 000 horse power and the American Castner Company of Niagara Falls used 6 000 horse power in 1901.

The mercury process possesses the advantages of dispensing with diaphragms producing directly pure and strong alkaline solutions and thus saving expense in concentration economical use of current and preservation of the anode owing to the absence of oxygen. On the other hand it possesses some great disadvantages especially the higher voltage required (4 volts instead of the 3 volts of the diaphragm process) technical difficulties caused by the use of mercury and moving parts and increased cost of plant. A 6000 horse power plant requires 7[illegible] tons of mercury costing $90 000.

The Austrian Bell process was designed to combine the advantages of both its predecessors and avoid their defects.

It employs instead of mercury or diaphragms the difference in density between the light anode liquid and the heavy alkaline solution which surrounds the cathode. This process is used in one establishment in Bohemia and two in Germany but it has the disadvantage of requiring very complicated and extensive apparatus. The Bohemian establishment of 000 horse power contains 2 000 bells or cells.

In order to trace the influence of electrolytic methods on the production of soda and chlorine a brief sketch of the history of those industries is required.

In 1790 the French physician Leblanc the father of chemical manufactures won the prize offered by the French Academy for a method of obtaining soda from salt. For a hundred years most of the soda and other alkalies and nearly all of the chlorine and hydrochloric acid used in the world were produced by the Leblanc process. During the French revolution Leblanc's patent was revoked his factory closed its contents sold and the proceeds turned into the public treasury. The impoverished and heart broken inventor ended his life with a pistol shot in his ruined factory in 1806. In the same year two new establishments for the production of soda by Leblanc's process were started in France and others soon followed. The process was introduced in England in 1811 but was not greatly developed until the enormous tax on salt was removed in 1823.

In Germany the manufacture of soda by the Leblanc process commenced in 181 and several factories were soon in operation. The process was adopted in the Griesheim chemical factory which was founded in 18 6.

An important characteristic of the Leblanc process is the production of a quantity of hydrochloric acid sufficient to neutralize all the soda produced. The acid remained largely a very annoying waste product until the demand for it was greatly increased by the general development of chemical manufactures and especially by the sudden use of the aniline dye industry and the introduction of the Deacon and Weldon process of producing chloride of lime about the year 1870.

The residue containing sulphur in combination with sodium constituted another troublesome by-product until methods of extracting the sulphur were devised.

The Leblanc process encountered no serious opposition until 1875 when Ernest Solvay introduced the ammonia soda process based on the insolubility of ammonium chloride in solutions of salt. Then began a competition which in a few years reduced the price of soda by one half. In Germany between 1877 and 1894 the annual production of soda by the Solvay ammonia process rose to 210 000 tons four or five times the production of Leblanc soda. In England in the same period the annual production of the ammonia process increased to 280 000 tons, and a similar development took place in France Belgium, and other countries. The total annual production of soda by the ammonia process amounted to 900 000 tons in 1900 1 600 000 tons in 1903 and now exceeds 2,000 000 tons.

The advantages of the ammonia process over the Leblanc process consist of the employment of lower temperatures with resultant economy of fuel in lessened cost of labor and repairs and especially in the possibility of employing cheaper raw material namely the crude brine as it is pumped from salt springs and mines instead of rock salt or salt crystallized by evaporation. On the other hand the Solvay ammonia process possesses the inherent defect that it utilizes only the sodium of the salt and throws away in the form of a worthless solution of calcium chloride the chlorine which the Leblanc process delivers in the valuable form of hydrochloric acid.

Hence the once despised hydrochloric acid became the preserver of the Leblanc process. As the price of soda fell the soda manufacturers became dependent on the sale of hydrochloric acid which assumed the position of the chief product. A large proportion of the sodium sulphate produced concurrently with the hydrochloric acid in the first part of the Leblanc process (the decomposition of salt by sulphuric acid) was not converted into soda but was sold to glass makers who had found the sulphate a cheap and satisfactory substitute for the carbonate.

The introduction of the Griesheim electrolytic process profoundly affected both the soda and the chlorine market. In 1890 German imports of chloride of lime exceeded exports by nearly 000 tons but in 1900 the exports exceeded the imports by 0 000 tons. The world's annual production of chloride of lime is now about 00 000 tons of which about one third is produced by the Griesheim process and one sixth by other electrolytic processes. The remaining half of the total is still produced by the Deacon Weldon process which employs hydrochloric acid obtained together with sodium sulphate in the first stage of the Leblanc soda process. But only a small proportion of the sulphate is now converted into soda. The sulphate is not only used largely in glass making but much of it is converted into sodium sulphide which is used in the manufacture of sulphur dyes and artificial silk. Almost all the German Leblanc establishments have ceased to produce soda.

The effect of the electrolytic process on the alkali market was first felt in connection with caustic potash which is chiefly used in soapmaking. The soapmakers soon found it more profitable to use the strong and pure electrolytic lye than to convert the carbonate into the hydrate and concentrate the latter with small imperfect and wasteful apparatus. In 1894 caustic potash was still imported into Germany but 2 000 tons were exported in 1904.

The further development of the electrolytic process depends chiefly on the chlorine market as though the demand for caustic potash is comparatively small the market for caustic soda is unlimited. Since the introduction of the new process a new market for chlorine has been found in the manufacture of various organic compounds including chloroform chloral carbon tetrachloride and chloracetic acid which is used in large quantities in making artificial indigo. Chlorine obtained by the electrolysis of salt is now liquefied and shipped to manufacturers of chloride of lime and other products not only in steel cylinders but in tank cars of several tons capacity.

The great theoretical expenditure of energy combined with the still imperfect utilization of current in the electrolytic production of chlorates restrict the employment of this method chiefly to districts possessing cheap water power especially in France Switzerland Norway Finland, and at Niagara Falls in America.

The latest commercial product obtained by the electrolysis of salt is hydrogen which at first was allowed to escape but is now though only to a small extent compressed in steel cylinders under a pressure of 150 atmospheres and sold for filling balloons and for use in the oxyhydrogen blowpipe for welding and cutting metals. Almost all German dirigible balloons have been inflated with hydrogen produced by the Griesheim electrolytic process.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

The plans for the proposed underground postal railway in Vienna are now under consideration, says Electrical Engineering. This railway will if constructed, connect up the chief post office with sixty-four substations and nine railway stations in the city. Letters, newspapers, and parcels will be carried on trains of eight cars running every twenty minutes. The trains will carry no motorman but will be operated from the stations, and will travel at a speed of about 20 miles per hour.

NEW GAS FUSION PROCESS.

A GERMAN IMPROVEMENT ON THE OXYHYDRIC PROCESS.

BY CHARLES R. KING.

PROCESSES employing such gases as acetylene or oxygen for the fusion of moderate thicknesses of metal have been in use for years for the soldering or welding of joints or the repair of defective or broken pieces, and have recently received especial literary attention under the important title of autogenous welding

In France where the process is merely termed 'blow pipe brazing —braze indicating a local melt over a brazier or hearth—the method has for a considerable time been found to be very convenient in *locomotive shops for fusing together the thin metal* sheathing or clothing of boilers which not being lagged with non-conducting materials should be hermetic in order to make a perfect hot air jacketing around the boiler and smokebox and for joining the flue tubes of boilers repairing superficial defects in locomotive frames mending brakes in the liners of piston valve chests and for a quantity of small work in which the joint by simple [illegible] is permissible without compromising the strength of the rolled cast or forged metal to which the process may be applied For flue tubes the oxyhydric fusing process is found to make a very tough joint the flue breaking anywhere but at the jointed part and it is very cheap and much more convenient than is the case even with model tube welding plants such as exist for instance in the locomotive works of the Saxon state railways near Dresden, but beyond a thickness of three millimeters the oxyacetylenic is found—on the Northern France Railway—to be the cheaper although as regards the details of operation the latter is more trying to the eyes of the operators but both these gas fusing processes are found to be dearer than furnace work *when the metal has to be fused to a depth of* several inches

In the oxyhydric gas fusing processes the heat is furnished by the combustion of the hydrogen and resides in its flame when applied to thin plates it rapidly penetrates the metal to the point of fusion as however the thickness of the plates increases the heat penetration becomes rapidly slower the heat of the flame spreading itself without effect through the mass of the metal and then being given off from the latter by the effect of irradiation The limitations of the processes in use have given rise to another blow pipe system embodying quite a different principle and suitable for fusing large masses of metal under conditions peculiar to the needs of large ironworks such for instance as unchoking the tap hole of furnaces stopped up with cooled metal and usually necessitating a slow and difficult work of clearance with the aid of steel bars sometimes too at a critical moment

The new fusion process has been introduced by the Koeln Muesener Bergwerks Aktien Verein and has been in successful use for the past few years In operation the mass of iron to be treated has first to be heated yellow high pressure oxygen is then discharged against it so producing combustion of the particles of the iron itself which being fused is driven away by the high pressure blast of the hydrogen Once the point of fusion is attained the heat is communicated with extraordinary rapidity to the rest of the metal in line with the blast It will be perceived therefore that although the gas employed is the same as that which is used in the so called welding process it is the gas in the latter that acts as the combustible whereas in the former it is the metal to be melted usually iron that constitutes the fuel The difference in the application may be understood from a consideration of the fact that one kilogramme (2 2 pounds) of hydrogen develops by its combustion as much as 28 700 calories (one calorie=2 2 B T U) *whereas one kilogramme of iron develops only* 1 [illegible]10 calories

On the other hand one kilogramme of hydrogen occupies a volume of 11 116 liters (one liter is 61 cubic inches or 1 76 pint) whereas the volume of one kilogramme of iron is only 0 128 liter It follows that the heat developed by one liter of hydrogen is equal to 2 58 calories while for the same volume of iron it is 12 900 calories In other words for a given volume the heat of combustion is 5 000 times greater for iron than for hydrogen Besides this the heat evolved by the combustion of 1 kilogramme of iron suffices to provoke the fusion of 4 4 more kilogrammes of this metal by reason of the rapidity before mentioned of the propagation of the heat through the iron particles neighboring the focus of the combustion and these latter are driven off by the blast before they can be cooled by the irradiation of their heat this being proved by the fact that masses of iron pierced by the blast and fused inside remain cold enough on their outside surfaces as to allow the latter to be touched by the hand It is precisely this peculiarity which renders the process of value for piercing or cutting large masses of metal without affecting adjoining parts outside of the line of the blast Thus the choked tap holes of blast or steel furnaces may be melted out without danger to the lining and even the tuyeres blocked with metal can be melted out the iron inside them being fused while the tuyeres themselves retain a relatively low temperature Here the fused metal is blown off immediately by the pressure of the blast or hydrogen blow pipe while the surface of the tuyeres is impinged continually with the cold oxygen blast

Besides being especially valuable in emergency cases such as those which occur in blast furnace work where any delay may endanger the life of a furnace the process is of particular use in steel works and rolling mills Running holes of steel furnaces are opened by it with rapidity and Martin furnaces and steel pockets are emptied promptly without any loss in the quality of the steel from its being kept too long in the furnace or without destruction of the steel pockets It is used in place of costly mechanical operations for the dismounting of pieces that have become rigidly attached together by long contact as foundation bolts shaft couplings etc and where in a local melt expeditiously solves some difficulty which can only be otherwise overcome by long and tedious mechanical means Already the process is employed in a considerable number of German metallurgical works the results being really surprising especially when a battery of hydrogen blow pipes is available with nozzles bent and curved in such a way as to enable *the fusing operations to be effected in all* directions to suit various contours

The Koeln Muesener apparatus consists essentially of a blowpipe having as in the oxyhydric welding blowpipe two concentric tubes Oxygen under pressure is delivered into the inside pipe while the outside tube serves for ordinary lighting gas under pressure for starting the action of combustion after which the coal gas is cut off The entire apparatus consists of

1 A cylinder of oxygen compressed to 1[illegible] atm pressure

2 A pressure reducer fitted with two gages indicating one the pressure in cylinder and the other the reduced pressure and also a safety valve

3 A flexible metallic pipe conveying oxygen at 30 atm pressure to the inner tube of the blowpipe

4 A cylinder of lighting gas compressed to 200 atm pressure

A gas pressure regulator identical with that for the oxygen and likewise fitted with two gages and a safety valve

6 A rubber pipe conveying lighting gas to the outer tube of the blowpipe

7 A blowpipe arranged as already mentioned Differing from the oxyhydric blowpipe or torch the two gases do not intermix before combustion the hydrogen tube being carried to the nozzle extremity of the blowpipe The inner tube is maintained in the center of the gaspipe by means of small adjusting screws

8 A series of carbon rings fitting the nozzle of the blowpipe and protecting its metal from the surrounding heat

To use the apparatus the gas in the outside pipe is turned on and lighted The oxygen is then turned on The metal to be melted having been first heated up to near upon the degree of heat of combustion of its constituent elements the lighted blowpipe is then directed on the mass until the combustion of it is started—when the coal gas can be cut off The time taken to fuse a mass of metal depends upon the thickness to pierce A case may be mentioned of a cylinder of steel 10 inches long which was pierced by this method in less than a minute The piece had not been previously heated for the operation and the diameter of the bore thus made was about inches

For those who know the limitations of the oxyhydric or oxyacetylenic process this example will serve to indicate the large difference of these compared with the Koeln Muesener system and above all when it is considered that the oxyhydric flame attains a temperature of 2000 deg C and that on the other hand the oxygen by its expansion cools at 10 deg C

The consumption of oxygen according to the formula $3F + 4O$ $Fe\ O$ is 80 grammes or [illegible]10 liters of oxygen to melt [illegible] kilogrammes of iron reckoning that 1 kilogramme of iron furnishes by its combustion the heat necessary to melt 1 4 additional kilogrammes

The oxygen is sold commercially in special cylinders costing in Germany the equal of 3 3 for one cubic meter (3 cubic feet)

The economy of the process is necessarily the greater where the price for hand or mechanical work is high In Germany such work is moderately priced and yet the saving is found to be considerable The cost of melting out the tap hole of a blast furnace is found to be 4s 2d to s reaching in the worst cases to 8s 1d In the case of emergencies the process is found to be invaluable the mere cost of gas being then immaterial The consumption of coal gas is very little because it is only used in starting the apparatus

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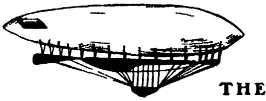
DEPTH OF THE GULF STREAM

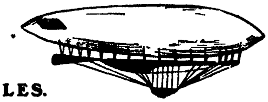
IN Lieut Pillsbury's examination of the Gulf Stream at various points from Hatteras southward, he found that the stream reaches to the very bottom in some places and tabulated its velocity at different depths His results, as well as a review of the whole field of Gulf Stream investigation, are found in appendix 10 report for 1890 of the United States Coast and Geodetic Survey It must not be inferred from the foregoing that all ocean currents extend to the bottom of the sea Many instances are at hand of ocean currents extending to great depths For example Admiral Ermінger of the Danish navy found that the northwesterly current in latitude 25 deg 04 min N longitude 65 deg 41 min W, prevailed to a depth of 200 meters, Commander John R Bartlett, United States navy, found a current in the Windward Passage to the depth of more than 800 fathoms (1,460 meters), and concluded that it reached to the bottom, between Key West and Havana the stream was measured in 1860 to a depth of 600 fathoms (nearly 1,100 meters) and was found to be only 10 per cent less than at the surface

It is well established that the Gulf Stream loses in depth temperature and velocity and gains in width especially after passing Cape Hatteras until the 40th meridian it becomes a drift current reinforced on its right flank by the powerful Bahama current Various measurements *for temperature* show that *the* Gulf Stream is shallower than its northeastern extension beyond the 40th meridian Thus Commander Chimmo R N commanding H B M S Gannet during the summer of 1868 found the warm water of the Gulf Stream to be less than 50 fathoms deep in latitude 44 deg 03 min N longitude 48 deg 07 min W Ten degrees to the eastward the warm water had deepened to 100 fathoms or more and in latitude 43 deg 43 min N longitude 37 deg 47 min W the warm water was found to extend down about 250 fathoms Observations made on board H B M S Porcupine during the summer of 1869 showed remarkable depths in the Gulf Stream drift as follows In latitude 59 deg 3[illegible] min N longitude 9 deg 11 min W the warm water was found to extend to the very bottom of the sea 767 fathoms (1,400 meters), at Rockall the warm drift was found to reach down 900 fathoms below the surface, and similarly again in latitude 47 deg 38 min N, longitude 12 deg 08 min W At the last mentioned observation spots the warm water was found to be underrun by a polar current at a depth of more than 900 fathoms A similar phenomenon is often observed *near the* **Grand Banks** *where the* Labrador current dips under the Gulf Stream at comparatively shallow depths 50 to 100 fathoms

The Production of Transfer Pictures Smooth unsized paper not too thick is coated with the following solutions 1 Gelatine 10 parts in 300 parts of warm water applied with a soft sponge laid flat and left to dry 2 Starch 50 parts gum tragacanth 10 parts in 600 parts of water (the gum tragacanth is dissolved in 300 parts of the water in the other 300 parts the starch is boiled into a paste in the usual manner) Dried sheets are painted with the tragacanth paste thickly but uniformly and allowed to dry again 3 Blood albumen 1 part soaked in 3 parts of water for 24 hours with small addition of spirits of sal ammoniac The sheets must be coated with these solutions and dried after each application Print with ordinary colors, but in reverse order



GERMAN AIRSHIP SHEDS.



THE PROBLEM OF HOUSING DIRIGIBLES.

BY OUR GERMAN AERONAUTIC CORRESPONDENT.

One of the most important questions in connection with aerial navigation is the providing of suitable places of refuge for the enormous dirigible balloons of which Germany is the proud possessor, and the final settlement of the question is rendered still more difficult by the fact that as regards the rigid types dirigibles of much larger dimensions than those already existing have been devised and are now in course of construction, so that it is hard to say when and where the limit will be reached.

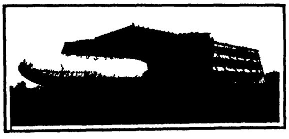


FIG. 1.—ZEPPELIN AIRSHIP EMERGING FROM THE SHED AT METZ.

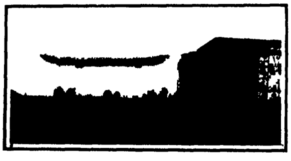


FIG. 2.—THE ZEPPELIN STARTING ON A JOURNEY.

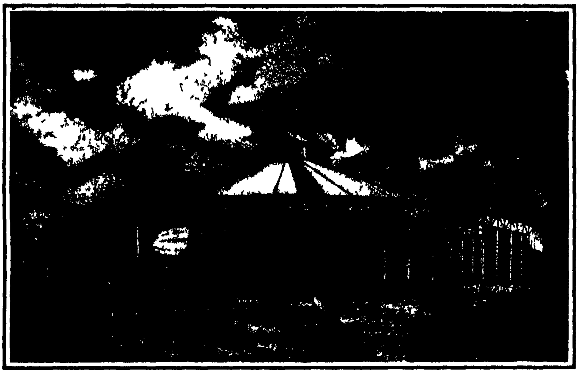
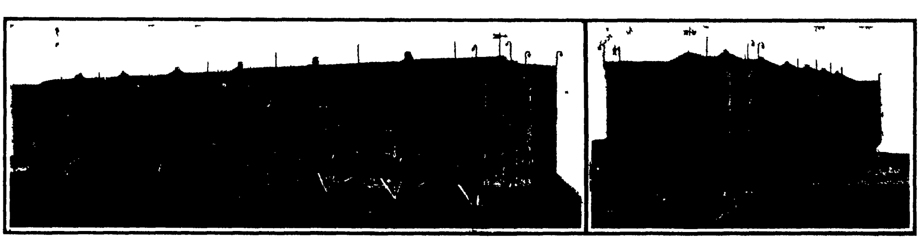


FIG. 3.—DESIGN OF A ROUND SHED MAKING POSSIBLE THE EMERGENCE OF THE AIRSHIP AGAINST ANY WIND IRRESPECTIVE OF ITS DIRECTION.

The first permanent shed of large dimensions in Germany, except of course the floating one built on Lake Constance by Zeppelin when he commenced to build the first monster, is that erected at Metz for the military station by [illegible] Bernhard of Berlin. The shed in question is 1[illegible]0 meters (14[illegible] feet) long, 40 meters (1[illegible]1 feet) wide and 31 meters (10[illegible] feet) high. It is calculated to hold two Zeppelin airships or four Gross or Parsevals. At present it harbors one Zeppelin, one Parseval and one Gross. It is an iron construction with walls of iron and wooden roof with tar-paper insulation. It has proved practical to have the walls constructed of corrugated iron in a building of such large dimensions, where the corrugated metal does not act as a good conductor of heat, so that a constant temperature is maintained at a cheap cost. The door consists of two sliding panels of corrugated iron, each having a surface of [illegible] square meters ([illegible]26 square feet). They are moved by a windlass on each side, each of which is operated by two men. Ten minutes is necessary in which to open or shut them. Our illustrations Figs. 1 and [illegible] give a good idea of the comparative size of the Zeppelin airship and the above mentioned shed. Such an oblong shed is not of the type which was desired by the Zeppelin Company, which has strongly urged the government to provide round constructions. The contention of Count Zeppelin is that a dirigible of such size as his can only land safely with its head to the wind, and that the shed can only be safely entered or left in the same direction. The correctness of his claim is clear to any one who has ever seen a Zeppelin landing in a strong wind, and even in the case of the smaller dirigibles of the non-rigid or semi-rigid types it is difficult and dangerous to bring one out of its shed with the wind blowing sideways or direct into the entrance. This was shown upon one occasion at the last aeronautical exhibition at Frankfort, when the envelope of the Parseval was badly ripped by being jammed against the door posts as the airship was being brought out in the face of a moderate breeze.

Fig. [illegible] shows a round construction designed by [illegible] Genz of Oberhausen, which was shown in model at the Frankfort exhibition. As will be seen, it is provided with entrances on all sides, and was specially designed to fill the requirements of the Zeppelin Company, but naturally the cost of such a construction is so much greater than the usual oblong buildings that the German government has not yet seen its way clear toward complying with the demands of the Zeppelin Airship Company. The floating shed on Lake Constance is also an oblong building, but as it is anchored at one end only, the wind always floats it into position, so that a round hall was not necessary. On *terra firma*, where the greater part of the sheds are to be erected, the turning round of a building of at least 150 yards in length is a somewhat more complicated affair. Photographs Nos. 4 and 5 show front and side views of an interesting solution designed by A. Klonne of Dortmund, which the firm offers to build up to the following dimensions: Length 150 meters (492 feet), inside width and height 25 meters (82 feet). The building is supported on wheels running on a circular rail so that it can be revolved to any desired point of the compass. A hollow float tank fitting in a circular reservoir supports the center of the shed. The reservoir can be filled with or emptied of water at will, so that when sufficient water is let into the reservoir the pressure of the wheels on the supporting rail is so far removed that comparatively little effort is needed to bring the entrance round to the lee side. In this way almost the same effect is reached as in the floating Zeppelin shed on Lake Constance, while the letting out of the water causes the building to rest firmly on the supporting rail again. A sail placed longitudinally along one end of the shed is sufficient to bring it into position when a moderate wind is blowing; otherwise it can easily be moved by hand machinery, horse or motor car. The building is just sufficiently lighted by means of windows and skylights, but not so extensively as to allow the rays of the sun to affect the dirigible it harbors. Ample provision is also made for ventilation and the removal of diffused gas. The roof and walls are covered by an asbestos mixture, selected on account of its light weight and its good insulating qualities. The construction of the door is clearly shown in the illustrations. It is of the folding type, operated by sprocket wheels and rail at the top and bottom, and when folded back fits into a latticed casement, as shown in the illustration.



FIGS. 4 AND 5.—SIDE AND END VIEWS OF THE KLONNE REVOLVING AIRSHIP SHED, WHICH IS MOUNTED ON FLOATS IN A CIRCULAR TANK.

TYPES OF GERMAN AIRSHIP SHEDS.

Another model is shown in Figs. 6, 7 and 8. This is of the non-revolving type, but has the advantage that it can be enlarged in length and height without in any way disturbing the previous construction. Besides this, no scaffolding is needed in its erection, and it can be put up on the most uneven ground. At a test a construction measuring in length 100 yards, in width 50 yards, and in height 25 yards was put up in 36 hours. Fig. 6 shows a model erected at the Frankfort exhibition with the canvas covering removed in order to show the construction of the supporting walls which consist of a series of iron frames and rails The frames with the exception of the end ones are interchangeable as are also the connecting rails A row of frames is connected together by the joining rails to the required length of the shed and successive rows are built up till the required height is reached whereby the framework itself takes the place of scaffolding Each frame in the original construction is 2 meters (6¼ feet) high and 1½ meters (5 feet) wide and weighs about 130 pounds They are strengthened by diagonal and transverse pieces and the connecting rails to the frames which are 3 meters (9 8 feet) long are fastened by studs and keyhole shaped orifices screw bolts and nuts being used for fastening two frames together

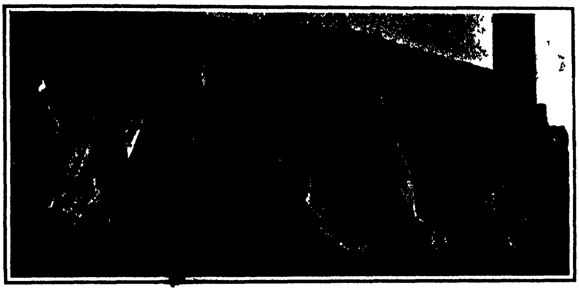


FIG 6—MODEL OF A SECTIONAL AIRSHIP SHED EXHIBITED AT THE FRANKFORT AERONAUTICAL EXPOSITION

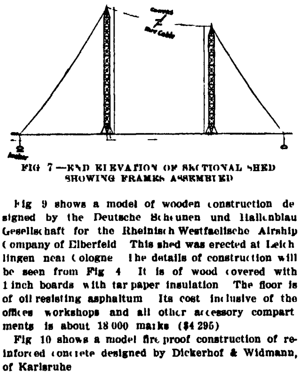


FIG 7—END ELEVATION OF SECTIONAL SHED SHOWING FRAMES ASSEMBLED

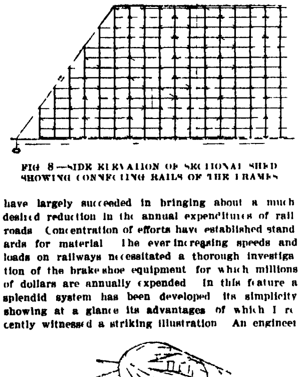


FIG 8—SIDE ELEVATION OF SECTIONAL SHED SHOWING CONNECTING RAILS OF THE FRAMES

Fig 9 shows a model of wooden construction designed by the Deutsche Schuppen und Hallenbau Gesellschaft for the Rheinisch Westfaelische Airship Company of Elberfeld This shed was erected at Leichlingen near Cologne The details of construction will be seen from Fig 4 It is of wood covered with 1 inch boards with tar paper insulation The floor is of oil resisting asphaltum Its cost inclusive of the offices workshops and all other accessory compartments is about 18 000 marks ($4 295)

Fig 10 shows a model fire proof construction of reinforced concrete designed by Dickerhof & Widmann, of Karlsruhe

It has also been proposed—as a means of avoiding the cost of erecting large sheds—to dig out excavations in the earth, so as to form airship docks at any place necessary Such an excavation can be provided with a sliding roof, and has the advantage that in addition to the small cost the airship does not have to be brought in through a narrow entrance but can be drawn down from above by means of ropes running on rollers at the bottom of the trench Fig 11 shows diagrammatically such a dock, which was described by the inventor, F W Olges some time ago in SUPPLEMENT No 1733 A complete description of the revolving shed with diagrams will also be found in SUPPLEMENT No 1749

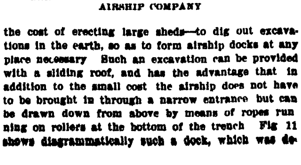


FIG 9 MODEL OF WOODEN SHED BUILT AT LEICHLINGEN FOR THE RHEINISCHE WESTPHALISCHE AIRSHIP COMPANY

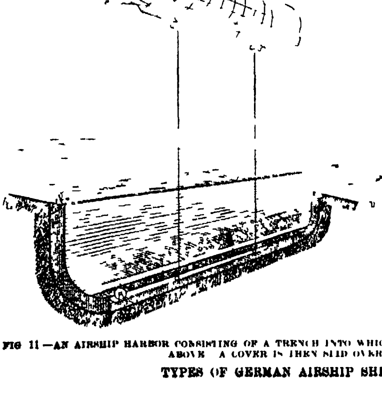


FIG 11—AN AIRSHIP HARBOR CONSISTING OF A TRENCH INTO WHICH THE AIRSHIP IS DRAWN FROM ABOVE A COVER IS THEN SLID OVER IT

TYPES OF GERMAN AIRSHIP SHEDS

BRAKE SHOE OPPORTUNITY.

MR WILLIAM WHITTAM Jr formerly a special agent of the Department of Commerce and Labor offers suggestions for the introduction into Great Britain of the quickly exchanged brake shoes made in the United States As to their usefulness he writes Railroads in the United States have neglected no opportunity to secure every means for economizing in rolling stock The good and effective work done by their Master Car Builders Association can not be overlooked With active committees that watch closely development of every kind supported by the manufacturers of railway material who specialize in every direction they have largely succeeded in bringing about a much desired reduction in the annual expenditures of railroads Concentration of efforts have established standards for material The ever increasing speeds and loads on railways necessitated a thorough investigation of the brake shoe equipment for which millions of dollars are annually expended In this feature a splendid system has been developed its simplicity showing at a glance its advantages of which I recently witnessed a striking illustration An engineer on one of the largest railways in the States was just about ready to pull out of the yard Before doing so he once more made an examination of his engine to make certain that everything was in running order Happening to glance at one of the brake shoes on the drivers of his locomotive and seeing that it was nearly worn to the limit he decided to replace it by a new one Although there was scarcely a minute s time to spare he accomplished the change in even half the time This fact and a scrutinizing of the worn out brake shoe he threw away which was a mere shell aroused my interest in the brake shoe industry Obtaining an introduction to the manufacturers of this material I found that the manufacture of their product as well as of their means of providing railways with brake shoes especially suited for the conditions of the various services was of considerable magnitude The output of one of the manufacturing plants was close to [illegible] tons per day A careful study of the iron used in their product is made in a well equipped laboratory There are special departments which cover certain requirements in the production of these shoes and which have minute attention in order to furnish the railroads with the best brake shoe material at the lowest cost which is fully appreciated and recognized among American railroad interests

FIG 10—MODEL OF A FIREPROOF AIRSHIP SHED OF REINFORCED CONCRETE

The time taken in replacing a worn out brake shoe in the United States is only a part of a minute while the changing of a brake in Europe takes many minutes Altogether there would seem to be an excellent opening for American enterprise in this direction It is clear that a wonderful opportunity exists in Great Britain and Europe for the export of the American type of brake shoe In Europe the solid shoe is common but this type became practically obsolete in the United States many years ago With this solid shoe a waste of 1 to 20 pounds of material occurs against a scrapping of but [illegible] to 7 pounds on the American plan

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The hilly territory of Trieste it is stated in a consular report on that district is covered by pointed stones which prevent any cultivation and some years ago the Società Agraria offered prizes for those who would remove them and thus change the waste ground to meadows The work has now been going on for some years and every autumn a commission ascertains the area of the proposed redemption and the difficulties to be encountered and fixes the prize to be given In spring it again visits the improved grounds and pays the prizes if deserved This year in the different parishes 66 peasants improved 44 acres

COFFEE AS A BEVERAGE.*

ITS USE AND ABUSE.

BY ROBERT AMORY, M.D.

The writer of this article having noticed in a printed statement that Col. Younghusband advised the preparation of a cold water infusion of coffee as a beverage to be taken during long outdoor journeys into the wild country of Thibet was tempted to prepare coffee in the same way for his own use. The result of experience taken in connection with the investigation of the well known composition of the coffee bean seemed to show that the same method can also be greatly improved for domestic use over the usual preparation of making an infusion by the use of boiling water. A cup of coffee may be prepared by passing cold water through finely ground coffee contained in a porcelain or china percolator such as the Austrian coffee biggin. This extracts only one ninth of the bitter caffeine and one fifth of the tannin contained in this bean. It will also preserve the aroma of the volatile oil contained in this bean. These advantages are so obvious that it is worth mentioning to those who are fond of coffee drinking but who wish to reduce the unpleasant results such as wakefulness, excitability and disturbance of digestive process, these conditions being largely due to the presence of caffeine and tannin which are very much more soluble in boiling and hot water used in the ordinary preparation.

The writer has tested this method for a period of more than five years and is well satisfied with the experience. The following article is intended to show the difference between coffee made in the ordinary manner and that made by the cold water method which is described later.

It may be interesting to learn the experience of one who has spent a long life in studying methods of preparing coffee beverage in various forms, namely with hot water, boiling water and cold water solutions for drinking. The correct process of making coffee beverage should be viewed from the standpoint of its chemical and physical constituents. This article will begin with a description of the coffee.

The coffee bean which is the product of cultivation in many tropical countries is gathered and dried by the sun and exported to the various markets, and is where it is used to a very large extent at a distance from the country in which it is grown.

This coffee bean, as is well known, cannot be used to produce an agreeable coffee beverage unless it is roasted and carefully ground to a fine powder. It should while roasting be continually agitated in order to remove the loose particles of its envelope, taking pains to heat the ground bean equally throughout its interior.

Coffee bean contains among other substances caffeine, tannin and the volatile oils; the latter give the aromatic flavor which is stronger when the liquid coffee is hot. This aroma will be increased if the grinding of the bean is rapidly conducted because the friction will set it free. The aromatic oils will be readily absorbed by cold water used in making an infusion.

The alkaloid known as caffeine is supposed to represent the active principle of coffee and exists as a latent element in the coffee bean. When isolated it is a white powder having a slightly bitter taste and an acid reaction. At [illegible] degrees it is soluble in one ninth of the amount of water required for its solution in hot water ([illegible] deg. to [illegible] deg. F.). Its solubility is increased in water containing calcium salts, potassium and sodium salts. These salts are usually contained in spring and well water (hard water).

It will thus be seen that caffeine at a high temperature will require [illegible] parts only of water for its solution, while at a low temperature it will require about nine times as much, and it will also be noticed that its solubility is increased by the presence of certain salts which are naturally contained in spring and well water.

Caffeine when given as a medicine separated from it often causes headache and in rare instances of susceptibility in the individual mild forms of delirium, noises in the ears, and flashes of light showing derangement of hearing and eyesight. Caffeine, especially in the form of caffeine citrate, is used in some cases to relieve headache, though in other susceptible individuals it may increase it. Where the action of caffeine is not followed by disagreeable sensation, as before stated, its absorption is often followed by increased mental action, sometimes a period of depression, oftentimes exhilaration, and in these cases interference with sleep. It has the peculiar action of exciting the muscles and in susceptible people may produce irregular muscular contractions and tremors. It may also sometimes affect the pulsation of the heart causing irregular action and interfere with the equable effect of circulation throughout the whole body.

Tannin (or tannic acid) is another ingredient of coffee bean. The Pharmacopœia (United States 1900) states that it is soluble in cold water only to a slight degree but very soluble in boiling water and in its solution will turn blue litmus paper pink, showing its acid reaction.

In the vegetable kingdom tannin is found in the oakgall and in a very large number of other growths. Both tannin and gallic acid with iron solutions form an inky substance suspended in water which is favored by heated water. The action of tannin when swallowed produces an astringent sensation in the mouth, throat and gullet and a disagreeable oppressed feeling in the stomach. Pure tannic acid appears in the form of a yellow colored amorphous powder. It is used in medicine as an astringent and produces a construction of the smaller blood vessels to relieve hemorrhage, also by its astringent action within the alimentary canal to relieve diarrhea.

The volatile oils which are set free by heating the ground coffee or by its infusion in boiling water stimulate the interior surface of the stomach and bowels and thus favor the digestion by increasing the peristaltic action of this part of the alimentary canal, especially in the primary stage of digestion.

Cushny states that in the stomach tannic acid combines with any proteid substance with which it may come in contact, precipitating it, but as digestion progresses this combination is broken up as the peptones do not combine with tannic acid in acid solution during the second stages of stomachal digestion and the astringent action is therefore exercised on the walls of the stomach and intestines. Ordinary quantities in the same supply [illegible] coagulation as in the mouth, but if large doses be given when the stomach and in the time is not protected by foodstuffs, a more complete coagulation of the mucous membrane takes place and the consequent irritation results in vomiting and sometimes in diarrhea.

The local application of tannic acid causes a diminution of the secretion of glands as has been demonstrated by Schutz. This is due to its effects upon the protoplasm of the secreting cells which probably undergo the initial stages of coagulation.

Another local effect produced by tannic acid is seen in the cessation of the movements of the leucocytes in the tissues around the point of application and the arrest of their diapedesis through the walls of the vessels.

Cushny (p. [illegible]) also states that coffee is not used in medicine, but in view of its immense dietetic importance it may be mentioned here in what respects it differs from the pure caffeine. The coffee bean contains about two thirds of one per cent caffeine, and the roasting does not seem to reduce this percentage at all as was formerly supposed, and since almost all the caffeine is extracted by the ordinary hot culinary preparation a cup of coffee contains 0.1 to 0.2 gramme (1½ to [illegible] grains) of caffeine. Along with the caffeine there are extracted a number of other substances, the most important of which are volatile substances produced by the roasting which have been called caffeon and resemble in their action the volatile oils.

The wakefulness and the relief from fatigue which are produced by tea and coffee are undoubtedly due to the caffeine contained in them and are to be ascribed to the central action chiefly, although the action on the muscles may also be of some value here. On the other hand the feeling of wellbeing and comfort produced by coffee after a full meal is probably to be explained by the local action of volatile oils in the stomach. The same result is produced by preparations of the other volatile oils and in fact these are often added to coffee in the form of brandy and other liquors. Apart from this local action the volatile parts of tea and coffee (theon, caffeon) seem to have no effect whatever on the economy. In the experiments on the activity of the digestive ferments outside the body it is found that caffeine increases slightly the rapidity of the process but that coffee and tea retard it considerably. On the other hand coffee probably owing to the volatile oils increases the peristaltic movements of the intestine while caffeine has no effect on them.

It was formerly stated that coffee lessened the tissue changes and that it ought therefore to be included among foods and one enthusiast even suggested that diet of tea and coffee exclusively should be served out in the besieged fortresses of France in 1870. It has been shown conclusively however that far from lessening the metabolism (organic interchange of tissue) of the body coffee and tea increase it, the amount of urea and carbonic acid excreted being considerably augmented by their use. This is only to be expected from the increased activity of the nervous centers which leads to increased movement and increased consumption.

Obviously from the above review of the physical and chemical constituents of coffee it will be observed that the beneficial effects of coffee beverage have a stimulant value upon the individual who drinks it. In order to avoid a deleterious stimulating effect upon the body caffeine and tannic acid should be excluded as far as possible from the cup of coffee while as much as possible of the volatile oil should be included in it; coffee therefore should be taken with food and not on a fasting stomach. After a full meal or during it coffee is beneficial to digestion as may be gathered by the foregoing remarks. If brain and muscular stimulation are desired it is much better to take caffeine, the exact dose of which may be limited. Again it is obvious that the hot or boiling water used in preparing coffee beverage should be avoided and the infusion of coffee should be made with cold water.

The writer of this article has for the last eight years prepared his coffee in a porcelain or china vessel with cold water and has carried it away with him for two or three weeks at a time, during which it did not lose its color, strength or aroma if kept carefully corked in a cool place. He always prepared this infusion in a concentrated form and just before drinking adds hot water, hot milk or hot cream (all these heated to boiling point) with the result of setting free the volatile oils. This produces a delicious cup of fragrant coffee which is free from the bitter taste of an excess of caffeine and tannin. In order to make an agreeable cup of coffee the following directions should be carefully observed. Grind the coffee rapidly to a fine powder, as the heat from rapid friction will excite the evolution of the volatile oils. It is important that the grinding should be done immediately before preparing the extract. If the ground coffee stands in the air the volatile oils will evaporate. The coffee should be ground to an impalpable powder. Place the ground powder in the upper part of an Austrian china biggin (percolator), leaving off the cover and the small saucer; put in a lump of ice and pour on cold water from a water tap (not well or spring water) and let the icecold water drop through the ground coffee, stirring the mixture carefully and thoroughly into a pastelike mass. To facilitate the percolation of the infused water extract it is advisable to place a small piece of wood between the lower edge of the receiver which contains the coffee grounds and the upper portion of the vessel which receives the infusion, as this leaves a little air space between these parts. When the liquid coffee infusion has all dripped through the percolator pour back through the wet grounds all the liquid from the bottom receiver and allow the percolation to go through the same process as before, replenishing the ice if necessary. Now place the lower portion of the biggin in a cool place and put on the cover. It should be noticed that the result of this, unless too much water is used in the percolation, will produce a very strong extract. This is desirable because in preparing it for the cup it is advisable to add sufficient boiling water to reduce it to the required strength, and the boiling water will set free the aromatic volatile oils which give the agreeable flavor.

The use of a metal "biggin" for preparing an infusion of coffee is entirely wrong for the following reason. The vegetable matter suspended in the liquid infusion collects in the angles of the bottom receiver and rapidly becomes the center of a decomposition, the result of which is accompanied by the development of micro-organisms which destroy the suspended particles left in the infusion, and these particles are what contain the agreeable taste of coffee. On the other hand clean china or glass does not collect these micro-organisms to any positive degree, especially when the coffee is kept in a cold place. Indeed if the hot coffee is placed in a corked bottle in a cold refrigerator the rapid cooling of this liquid will so shrink its volume that the reduction of bulk will suck in the cork of the bottle. "Hard water" such as well or spring water should not be used in preparing coffee because both of these contain salts in solution, as previously mentioned, which favor an increase in the proportion of the caffeine and tannin contained in the bean and would give it a bitter taste In restaurants coffee is often prepared in large metal vessels, provided with a method of heating by gas or electricity so that it may be always kept hot and ready for use This is one of the reasons why it has a charred taste It would always be ready for use if made with cold water and could easily be made hot by adding the boiling water when needed for use If any of the readers of this article will try making coffee by the above method the writer feels sure that they will never again make boiled coffee to drink

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* Boston Medical and Surgical Journal

METABOLIC ACTIVITY OF BEES.

HOW BEES UTILIZE OXYGEN.

ALL living creatures use oxygen during their life, and form carbon dioxide Life depends upon this reaction The magnitude of this metabolism of gas i e, respiration, is by no means equal in all animals in proportion to their weight Small birds for example, show a very high respiratory activity cold blooded animals such as frogs and fishes a very low one The quantity of oxygen absorbed also does not necessarily correspond exactly to the carbon dioxide given off since a formation of the latter gas can result from processes of decomposition in the blood unaccompanied by consumption of oxygen On the other hand a part of the oxygen absorbed goes to form water The ratio of the expired carbon dioxide to the oxygen absorbed at the same time is called the quotient of respiration

It is of the highest interest, therefore to ascertain the ratio of this gas metabolism in different kinds of animals because there is thereby given in various ways an explanation for phenomena which are otherwise inexplicable Marie Parhon has published (Annales des Sciences Naturelles) her searching highly interesting investigation into the metabolism of bees during the four seasons of the year in which she worked on an average with about 600 insects at one time

The results of the experiments show that the respiratory gas metabolism in bees is exceptionally vigorous as compared with other animate creatures A few figures may serve to illustrate this

	Temperature Degrees C	Oxygen per Kg and 1 Hr C m	Carbon Dioxide per Kg 1 Hr C c	Quotient of Respiration $\frac{CO_2}{O_2}$
Bees	20	17 3 6	17 57[illegible]	1 01
Flies	19	6 709	[illegible]	0 [illegible]9
Flies	20	4 980	5 729	1 14
Dog	21	911	674	0 74
Chicken	19	740	67	0 90
Man	20	213	166	0 78
Lizard	20	134	100	0 75
Frog	20	70	[illegible]	0 80
Carp	8	55	37	0 66
Crab	12 5	38	33	0 86
Starfish	12 5	32	25	0 78

The figures given here for bees are those which the authoress obtained in summer and while the bees were exposed to a temperature of 20 deg Experiments carried out under the same conditions (20 deg) gave in spring 23 754 cubic centimeters of oxygen and 30 408 cubic centimeters of carbon dioxide In fall 24 795 cubic centimeters of oxygen and 2[illegible] 881 cubic centimeters of carbon dioxide and in winter 22 549 cubic centimeters of oxygen and 23 038 cubic centimeters of carbon dioxide The maximum of respiration occurs therefore under this condition (20 deg) in the spring the minimum in summer For other temperatures the results were as follows

10 deg maximum in summer minimum in winter
32 deg maximum in fall minimum in summer
35 deg maximum in fall minimum in summer

In spring fall and winter the maximum of gas metabolism is not at 10 deg but rather at 20 deg In winter the exchange of gas stops almost entirely at 10 deg and the cold causes the bees to speedily become torpid

It appears from this that the exchange of gas in bees varies indeed with the temperature of their environment but that the changes thereof do not occur in the same manner as in the case with cold blooded animals The bees have within certain limits the ability to regulate their temperature and resemble therein the warm blooded animals While with the latter however the increase of gas metabolism proceeds as far as very low temperatures a stop occurs with bees at 10 deg or 20 deg In the struggle against cold the warm blooded animals are better equipped not so however in the struggle against heat For the latter the warm blooded animals have only one means an increase in the loss of heat bees possess in addition thereto the means of reducing the production of heat by abatement of respiration

Measurements of temperature show that the heat produced in the different part of the year is paralleled by metabolism of gas as a rule

The vigorous respiration of the bees is explained by the diversity of their activities which is a result of their gregarious life Since the nature of these activities and the exterior temperatures is different for each season of the year the gas exchange cannot remain the same during the entire year It varies with the season of the year and within the same season with the temperature of the environment in that it increases (within certain limits) when the temperature falls and conversely The struggle of the bees organization against the change of temperature of the environment is particularly noticeable during the transition periods of the year i e spring and fall At 20 deg for example bees consume in summer 17 liters of oxygen per kilogramme an hour in fall 21 liter at [illegible] deg 11 liters in summer and 17 liters in fall As an aid to the comprehension of this ratio the authoress calls attention to the fact that upon entering a subterranean chamber (of a constant temperature) we experience a feeling of warmth in winter but of cold in summer since our peripheral nervous system accommodates itself in the different seasons of the year to different temperatures Similarly the bees since they are for the most part in the open during the summer and therefore at an average temperature of 20 deg are accustomed to this temperature but in fall and winter on the other hand when they are in the hive at a temperature of [illegible] deg they are accustomed to this higher temperature When they are thereafter brought to a temperature of 20 deg in a subsequent season of the year they experience a lower temperature and react therefrom by increasing the metabolism of gas The noteworthy elevation of the gas metabolism in spring (34 liters of oxygen) can however not be attributed alone to the struggle against the cold here the return to the activities of summer operate as a provocation

The bees strive against the cold however not only by increasing the production of heat but also by decreasing the loss thereof Among the causes for the *abstraction of heat from living organisms* perspiration is one of the most important Experiments have shown that the loss of water from the bodies of bees is much less in winter than in summer By retaining water in their tissues during the cold seasons of the year the bees save the heat necessary for the evaporation of that quantity of water They strive in a similar manner against the heat in addition to decreasing combustion by also separating a greater quantity of water

The quotient of respiration varies very little from one season of the year to the other It oscillates generally about unity but is often equal to 1 This quotient of respiration is proof of an alimentary process rich in carbohydrates No honey which is the most valuable nourishment of bees contains 70 per cent of grape sugar and 6 per cent of cane sugar (in addition of 23 per cent of water) One can assume therefore that almost the entire quantity of carbon dioxide which is generated by the bees comes from the combustion of grape sugar

Nitrogen which bees need is obtained *from the pollen* of which they lay in a supply for the winter The authoress found by a microscopical examination in winter that the alimentary canal of the bees was filled with grains of pollen Since therefore this nourishment is at their disposal during the entire year it is clear that the content of nitrogen in the bodies of bees will not change during the seasons of the year as experiment demonstrates The quantity of glycogen in their bodies also remains almost constant during the entire year Since the bees carry carbohydrates into the hive and always have a supply there they do not need to store it up in the form of glycogen in their bodies Wissenschaftliche und Technische Wochenschau

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SUNSPOTS AND MAGNETIC STORMS

PROF R A GREGORY recently gave the first of two lectures which he had promised to deliver at Queen's College Harley Street The subject was Sunspots and Magnetic Storms and the lecture was illustrated by a series of limelight views By means of photographs of the variations of the magnetic needle the lecturer showed how in addition to the usual variation of the needle from the direct North there were occasions when it revealed more irregular disturbances and this occurred at the time of the magnetic storms of 1892 and 1905 when there happened to be large spots on the sun In consequence it had been suggested —and the suggestion at first seemed a plausible one—that the sunspots were the cause of the magnetic storms This theory was not however accepted by astronomers and men of science

Examining more closely the connection between sunspottedness and the magnetic conditions of the earth, Prof Gregory showed a table prepared at Greenwich Observatory from the records of the daily photographs of the condition of the sun between the years 1878 and 1905 which demonstrated that the average daily spottedness varied every year and that the interval between the minimum degrees was between eleven and twelve years This periodic fever of the sun was thus very definite The spots themselves did not break out all over the sun's surface but were confined to two zones a few degrees north and south of the sun's equator It was a definitely ascertained fact that just after the minimum of the sun's spottedness the spots began to break out away from the sun's equator and gradually worked down toward the equator A diagram was shown illustrating the wavering of the magnetic needle which corresponded with the rise and fall of the sunspots and the variation also of the Northern Lights which were caused by the discharge of electricity in the higher atmosphere, so that the lecturer said we had the earth's electricity and the earth's magnetism both connected with spots on the sun These magnetic storms however had no connection with the eleven year intervals he had spoken of but it had been ascertain that there was an interval of about 27½ days between them and in all probability that interval was connected with the rotation of the sun on its axis in a period of about twenty five days This rotation however differed in different parts of the sun —a difference that could only exist in gaseous bodies—and the rotation was the key to the table which showed an interval of twenty seven days between magnetic storms Some part of the sun which was more active in ejecting material than other parts sent out influences that might be related to sunspots and that disturbed our magnets

Sunspots were probably storms in the sun's atmosphere and Prof Hale director of the Solar Observatory of the Carnegie Institution of Washington California had succeeded in photographing the gases separately on the sun's surface Two photographs were shown of calcium and hydrogen so taken the hydrogen being in a high state of turmoil, and the lecturer said that Prof Hale had proved that this vapor rotating with great velocity was in a highly magnetic condition and they deduced the fact that these storms might really be the cause of the disturbances in the earth's magnetism That was a simple way of stating it but it was only the beginning of a very difficult inquiry It had been suggested that it was not the sun which disturbed the earth at all but that there was a great wave passing through the Solar System of which both the sun and the earth were victims but at present the question must be left where it was

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A disposal service for the handling of material excavated at building *foundations* building rubbish ashes from power plants etc is being operated by the Chicago Subway Company which owns a system of some 40 miles of small deep level tunnels under the city of Chicago Spurs are run to deep basements or to shafts where the materials are loaded into cars which are hauled by electric locomotives to a disposal station on the west bank of the Chicago River near Madison street Here there is a shaft over which are the runways for two electric trolley hoists each operated by a man riding on the machine When a car is set at the bottom of the shaft the body is hoisted up and run out over a dump scow moored alongside the station The car body is lowered and the bottom released discharging the contents into the scow The empty body is then run back and lowered upon the car frame at the bottom of the shaft

THE GREAT GUANO DEPOSITS OF PERU.*

THE FAMOUS CHINCHA ISLANDS.

ON the coast of Peru opposite the bay of Pisco nearly midway the equator and the tropic of Capricorn and something over 100 miles south of Callao lie the Chincha Islands

These islands and the mainland opposite are in the dry zone of Peru the *zona seca* in which rain so seldom falls that aged men can count on the fingers of one hand the times in their lives when they have seen this marvelous thing water falling from the skies

These islands are small high and rocky barren and uninviting to the last degree yet out of them has come wealth to stagger the dreams of Oriental imagination One thousand million dollars has been paid for the guano of the Chincha Islands Reckoned in gold it would take 1 000 heavily laden pack mules to transport the weight a train perhaps 30 miles in length

It is doubtful if there be another spot of equal size on the earth's surface from which so much wealth has been taken as from the guano beds of the Chincha Islands

But these islands were not the only source of Peruvian guano The Macabi the Guanape the Lobos the Ballestas and the Huanillos and the Pabellon de Pica have also furnished quantities of guano Besides these there are scores of small islands and points along the mainland where guano exists

The word guano or huano is the Spanish rendering of the Peruvian word *huanu* meaning excrement There are many varieties of Peruvian guano having different fertilizing values due to their different chemical constituents but these were all more or less alike in their origin They were all mainly the excrement of marine birds mixed with the remains of the bird themselves and perhaps some fish or seal remains

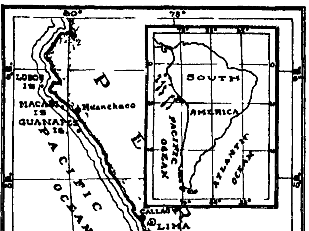
The deposits were from the most recent to the very old In some cases on the Chincha Islands they reached a depth of 160 to 180 feet The lower strata of such deposits might be thousands of years old

Nowhere else in the world are marine birds found in so great quantities as along the west coast of South America from Panama south to Chile The great majority of these bird have their roosts and breeding places on the Peruvian Islands or on points of the mainland Their presence in such immense numbers is due to the quantities of fish found along these coasts upon which the birds feed Cormorants pelicans sea gulls marine crows etc in clouds numbering hundreds of thousands may be seen at any time flying low to or from the islands or hunting their food But the birds alone could not have produced the Peruvian guano it was necessary to have the rainless climate of these islands in order to accomplish the result

There are hundreds of bird islands in other parts of the world some in the United States but the excrement and remains of the birds found thereon is not Peruvian guano although the deposits may be valuable for fertilizing agricultural lands Even with the Peruvian guano chemical analysis shows great differences

Manures are of three kinds as supplying the three constituents needed for plant life nitrates phosphates and potash These constituents are found in a natural state in all good soils although generally not well balanced nor are the two latter found always in an available form The constituent most often wanting is the nitrogenous and this is the most easily lost and most costly to supply in any artificial form

All excrements contain fixed nitrogen in the form of urates and salts of ammonia but these are to a large extent lost unless the manure is at once applied to the land and even then the nitrogen may be washed out before it can be made available for plant growth When left exposed to a humid atmosphere for any length of time or rain is allowed to fall on it the fixed nitrogen is rapidly leached out It is on this account that Peruvian guano in its natural state never having been exposed to rain or dampness has retained its nitrogenous properties and is more valuable than other guanos Some Peruvian guano contains all three elements of plant life and all of it contains the two elements phosphates and fixed nitrogen The latter as has been said is the most valuable element from a commercial standpoint



MAP SHOWING LOCATION OF THE GUANO ISLANDS

When first sent to Europe guano was sold at a fixed price per ton without regard to its chemical analysis This price was at first as low as $40 or $50 per ton but later rose to $60 and $70 Subsequently the price was made to depend on analysis and on the London market which set the price It was estimated at 19s d each unit per cent per ton for the nitrogen and 2s 3½d on the same basis for the phosphates the latter calculated as tricalcic phosphate and the former as ammonia

The proportion of ammonia varies in the different guanos and in different layers of the same deposit It may run from a very low percentage up to as high as 25 or even more in the best samples of Chincha guano The phosphates may run from 20 or 30 up to 75 or 80 per cent First-class Peruvian guano is such as contains above 10 per cent ammonia

When the Spaniards came first to Peru they found the natives using guano on their crops of maize, aji, and alfalfa The deposits were regularly worked and each village had its proportion of guano from the islands allotted as a necessary element in growing crops just as it had its proportion of water from the great irrigation canals coming down from the high Andes The Incas were skilled agriculturists the early Spanish settlers in Peru were not so both the irrigation works and the application of guano fell more or less into disuse But its use was never entirely abandoned and was known to Spanish writers during the sixteenth seventeenth and eighteenth centuries although practically unknown to the rest of Europe and to North America until well into the nineteenth century

The credit of first bringing it to the serious attention of Europe is ascribed to Humboldt who in 1804 brought a specimen from the Chincha Islands which was analyzed by several of the leading European chemists But it was not even then that its value was fully recognized and not until Liebig had taught the world the value of artificial manures was Peruvian guano estimated at its true worth In 1840 a firm of Lima merchants sent the first cargo to Europe consigned to a Mr Myers of London Two years afterward the amount transported to England was 182 tons and twenty years thereafter in 1862 it was 435 000 tons Between 1851 and 1860 the amount of shipping that loaded at the Chinchas represented 2 860, 000 tons and between 1863 and 1872 guano to the amount of 8 000 000 tons was shipped from the north and middle islands In this last year the Peruvian government prohibited the further export of guano from this group

The Guanape Islands about 30 miles from Santa were first worked in 1869 and in three years 838 853 tons of guano were taken off These are two small islands the larger less than three-fourths and the smaller less than one half mile across About 60 miles north of the Guanapes and 40 miles from Huanchaco the port of Truxillo are the three Macabis Shipment of guano began from these islands in 1870 and two years later the quantity of deposit remaining was estimated at about 400 000 tons These islands are all north of Lima the Chinchas are to the south

Still farther north and near the Ecuador border is the Lobos group The outer island of this group Lobos de Afuera contained a very large deposit and the inner island Lobos de Tierra another deposit of considerable extent

However prior to the war with Chile which began in 1879 the principal source of exports of Peruvian guano after the exhaustion of the Chincha deposits was from Tarapacá the most southern province of Peru and which was ceded to Chile at the close of the war in 1881

These deposits were carefully examined in 1874 and found to exist at the north point of the table land, which extends to the river Loa in 21 deg 23 min S on an elevated cliff called Huanillos in 21 deg 15 min S and at Pabellon de Pica an immense cone rising from out of the sea 1,000 feet, with slopes formed of guano deposits, in 20 deg 58 min S There were smaller deposits at Chomache, Islotas de Pajaros, Quebrada de Pica and at Patache

Estimates as to the original amount of these deposits varied, but it was probably in the neighborhood of 2 000,000 tons In 1876 there were more than 300 ships taking cargo from these southern deposits.

CHUTE FOR BRINGING DOWN GUANO

SHIPS LYING OFF SHORE WAITING TO LOAD GUANO.

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* Bulletin of the International Bureau of American Republics

After the exhaustion of the principal deposits on the Chinchas—all the deposits were not exhausted the decree 1872 prohibiting export preventing this—the export of guano fell off The amount shipped from this date until the breaking out of the war with Chile was still considerable about 350 000 tons or over a year This represented an annual value of over $20 000 000

During the war the guano industry fell into the hands of the Chileans By a decree February 9th 1882 the Chilean government ordered a sale of 1 000 000 tons of guano half the proceeds of which were to go to the Peruvian creditors By the treaty made by Chile with the Iglesias government which was ratified on March 8th 1884 and which ended the war and the Chilean occupation Tarapacá with the southern guano and nitrate deposits were unconditionally ceded to Chile Peru retained all the remaining islands but the industry was for the time destroyed The best deposits were worked out and though during the sixties and seventies a stream of gold reckoned in units of millions had been poured into Peru the country had but little after the Chilean war to show for it But the guano beds were not depleted and the myriad web footed birds sailed up and down the coast nightly sought its rocky islets and there bred and reared their young Guano making was still going on and with a policy of conservation Peru might draw for centuries a large revenue from the industry The swarms of fish in the ocean the rainless climate and the birds were there It was then that the policy somewhat similar to that applied by the United States in preservation of the fur seal herd of the Alaska islands—which policy was successful until the coming of the pelagic seal hunter was adopted in Peru for the exploration and preservation of the guano industry

TAKING OUT THE GUANO

In 1890 a contract was entered into with the Peruvian corporation which had taken over the State railways giving it the exclusive right to export guano up to 3 000 000 tons Under this contract the corporation has worked ever since and the receipts from guano have risen to over $110 000 a year

This contract has not always worked smoothly there have been many disputes in relation to it but at the present time these have been for the most part adjusted

In all the corporation has exported in eighteen years about 1 000 000 tons of guano The shipments in 1898 amounted to 21 826 metric tons (of 2 204 6 pounds) and in 1899 to 30 795 tons Since then the amount has increased In 1905 it was 73 369 tons worth £285 729 and in 1906 90 413 tons worth £361 652 It can be seen that Peruvian guano has not deteriorated in quality and is still the highest priced and most valuable fertilizer in the world The exports in 1906 were to five countries—Great Britain 30 234 tons Belgium 26 198 tons United States 16 155 tons Germany 15 888 tons and Holland 2 438 tons In 1907 about 106 000 tons were taken from the islands of which amount about 80 000 tons were exported and the remainder used locally During the year 1909 the only guano exported is that from the islands north of Callao The deposits to the south are reserved for the uses of domestic agriculture

No complete survey has yet been made showing the amount of guano deposited on the islands each year In a report made in March 1908 to the Minister of Fomento by Mr Robert E Coker who had studied the subject in reference to the Ballestas in one season there were deposited 2 000 metric tons covering about 20 000 square meters, and on the south island of the Chinchas the deposit covers 60 000 square meters and amounts to 5,000 tons This guano is of the very best quality

These two deposits cover a comparatively small part of the territory The report deals only with two of the groups and of one island only of one of them On the Guanapes the Manabis the Lobos and the other islands to the north the deposits are many times greater and if properly protected can be made to yield a sum much greater than that now derived through the Peruvian corporation

The methods used in working the deposits have not been the best but these methods are being improved

Under the old Inca civilization of Peru the guano islands were apportioned to the several provinces of the empire the deposits were carefully guarded and the manure fairly divided Closed seasons were enforced and care exercised that the birds were not unduly disturbed It has been the policy of the Peruvian government in recent years to revive the old Inca regulations enforcing closed seasons and rotation in digging

By a decree of December 28th 1904 the digging of guano between the months of February and November was prohibited under a penalty of $10 per ton This is the beginning of legislation in the right direction for the preservation of this one of the most valuable assets of Peru

THE NORWEGIAN FISHING INDUSTRY

The Norwegian winter cod fisheries begin as a general rule during the first part of January each year and last until June These fisheries are conducted along the shores of the central and northern parts of the country, the Lofoten Islands from remote ages having been considered the best grounds During the season the fishermen gather at the several fishing stations in these islands from all parts of the north country With the modern and larger craft now used many of them provided with motors the men are enabled to frequent more distant fishing banks and it has therefore been found more profitable than formerly to fish much farther south where the banks are farther out to sea The fish are seldom taken more than twenty miles off shore along the Lofoten Islands and the best catches there are often made only two to three miles from shore Nets set lines and hand lines are used indiscriminately Some 8 000 men with 19 000 craft of different kinds and dimensions are annually engaged in the Norwegian winter cod fisheries The winter cod is prepared for market by the Norwegians in two different ways either by what is known to the trade as stockfish or else by what is termed klipfish The latter according to the American consul at Christiania is known in Latin countries where both kinds find their best market as bacalao In the preparation of stockfish after the head and entrails have been removed the fish are strung together in pairs by the tail fins and hung unsalted on horizontal poles resting on beams placed on uprights where they are left until perfectly dried For klipfish the head and entrails are removed the fish split along the belly and the upper part of the backbone removed The fish is then salted and piled in suitable buildings in regular layers and finally in due course of time taken out worked free of surplus salt and carefully cleaned of black membranes on the belly side and then cured in places where suitable flat rocks are found convenient for the purpose Sometimes more than 100 000 fish may be prepared in this way in one place giving employment to a great number of persons mostly women and children Klipfish is well known under the general appellation of codfish (salted) Among the by products of cod are the livers from which is extracted oil prepared either for medicinal or mechanical purposes and the roes The roes are to some extent prepared and canned for food and the larger portion is salted in barrels and exported to France and Spain where they are used at the sardine fisheries The heads of cod and the backbones of the klipfish are dried and ground for fertilizers The number of cod and the by products obtained during the last season were 40 000 000 cod of which 26 000 000 were prepared as stockfish and 14 000 000 as klipfish 17 000 barrels of medicinal cod liver oil 24 700 barrels of livers for machine oils and 41 000 barrels of roes The prices paid to the fisherman vary considerably according to time and place The average catch at the Norwegian cod fisheries for a period of forty two years covered by statistical reports is 50 000 000 codfish per annum and this figure was reached in 1909 for the first time since the year 1897

A box of crocodiles eggs one of many which had been packed for export was accidentally left in a storehouse in German East Africa A few weeks later the box was found swarming with healthy and lively young crocodiles which had been hatched out in close confinement and without any care In order to hatch crocodiles eggs it is only necessary to place them in moist sand which is kept at a temperature of 104 to 113 deg F by means of a lamp beneath The young crocodiles may be fed with raw meat and fish

CORMORANTS

Photograph from American Museum of Natural History

USES OF BAKELITE.*

ITS ELECTRICAL AND ELECTROCHEMICAL APPLICATION.

BY L. H. BAEKELAND, SC.D.

Concluded from Supplement No 1774, page 11

Impregnating Processes. Liquid A specially in its extra thin variety is readily absorbed by any porous materials. Its penetrating power is far superior in this respect to varnish solutions rubber solutions or similar viscous or incompletely dissolved masses which have a tendency to merely stay on the surface notwithstanding the aid of high pressure.

If a piece of non resinous soft wood like basswood or poplar wood be immersed in extra thin liquid A after a few hours it will be found that the wood has doubled or even tripled its former weight. The absorption of the liquid is accompanied by some swelling of the wood and the latter becomes translucent on the edges which shows that the interior of the individual wood fibers is entirely filled. The same treatment can be given to unsized paper paper pulp cardboard asbestos objects of cement or plaster of Paris. In fact to any material of a fibrous cellular or otherwise porous texture.

For such articles which absorb easily regular liquid A can be used although it is somewhat thicker. In this instance slight heating will render it more fluid. In other cases it becomes necessary to use extra thin liquid on account of its greater penetrating power. The addition of solvents like alcohol or others does not work well except in special cases as for instance thin sheets of blotting paper because these solutions do not seem to penetrate as well furthermore the use of solvents introduces a new factor which retards the synthesis.

Resinous woods like pine are very difficult to impregnate. Bass poplar and similar woods as well as unsized pulp board are easily impregnated by plain soaking and this can be helped by the usual methods of injection under pressure. The preliminary use of a vacuum does not seem to be so advantageous from the fact that when liquid A enters the vacuum chamber it dissociates evolving formaldehyde gas and the liquid starts boiling and foaming violently. I found it much simpler to heat the substance that has to be impregnated at about 120 deg C for several hours until all water and air is expelled and then to immerse the objects while they are still hot into the liquid A where they are left to soak. If more complete impregnation is desired the force pump may be resorted to.

The impregnated material is now transferred to the bakelizer and submitted there to final treatment.

It should be borne in mind that we have to deal here with chemical phenomena occurring in capillary spaces. Under the latter conditions chemical reactions are considerably retarded. The chemical dynamics here are much influenced by decreased mobility of the reacting molecules. For this reason it is necessary to heat longer than for ordinary conditions.

On the other hand the capillary conditions depress at the same time the tension of dissociation this explains why wood or cement impregnated with liquid A can be heated at temperatures somewhat above 100 deg C without applying pressure and yet not give a porous result. So under these special conditions a bakelizer can be dispensed with by raising slowly the temperature from 70 deg to 130 deg C. But even then we have to guard against a considerable loss of formaldehyde vapors which are set free during the first period of heating and which may prove a disturbing factor by altering too much the chemical composition of the impregnating material.

So that after all whenever heating in a bakelizer is practicable it ought to be preferred even if only for the fact that it will shorten the heating process very considerably.

It is advisable to supplement the treatment with a slow after drying so as to expel any traces of water which may have been liberated during the synthesis.

In most instances it will be found that the impregnated objects have a dull appearance on the surface. Whether this be due to the fact that the pressure in the bakelizer has forced the liquid inward or whether it has to be ascribed to surface evaporation it can be easily remedied by applying a second superficial coat of thicker A.

The latter is best applied while the objects are still hot this treatment will impart a very hard and very glossy surface.

Wood thus treated is not only much harder and stronger but it has become rot proof and is a better electrical insulator. It withstands dilute acid solutions and ordinary electrolytes. It can be used to excellent advantage for third rail covers. Similar usages can be found for impregnated pulp board cardboard and asbestos board.

Asbestos paper or asbestos tissue impregnated with A or B makes an excellent packing material for gaskets washers and similar purposes.

In that condition it can be carried in stock indefinitely either in the form of flat sheets or in ready made sizes. As soon as this packing material is applied to a hot surface under pressure the A becomes plastic and molds itself thoroughly over the surface and is gradually transformed into hard permanent C.

In certain cases the admixture of graphite or similar filling materials may prove advantageous.

The impregnation of coils for dynamos motors and transformers. Bakelite gives us a ready means to provide these apparatus with a hard and strong insulating mass which cannot soften under the influence of heat and withstands temperatures at which all hitherto used gums or resins would melt away. Every electrical engineer knows what this means in relation to running overloads.

But the use of bakelite for these purposes involves new questions in the technique of impregnation. It should not be forgotten that by the synthesis of bakelite a certain amount of water is set free and this water must be eliminated from the coils by after drying. Furthermore bakelite in its final state C although very hard and tough is not flexible so that any wires or conductors coated with it can no longer stand much bending or twisting and for such parts the bakelizing operation should only take place after all wires and conductors are in their final place.

With this aim in view the wire or conductor provided with its covering of cotton or asbestos can be simply coated with dissolved A solution properly diluted with the necessary amount of alcohol then submitted to spontaneous drying. This may be helped by a gentle application of heat but never more than is necessary to carry the material to the stage B so as to maintain the necessary flexibility. The wire is now wound as usual and in order to insure more flexibility it may be found useful to heat it slightly. Tape or any fabric or asbestos impregnated with A may be put between successive layers just as is done when shellac is used as an insulator. After the coil is made up it is now introduced in the bakelizer.

In case the wires are covered exclusively with asbestos it will be advantageous to heat the bakelizer at highest temperatures however if cotton or similar organic materials be present such high temperatures would destroy and carbonize them and it may be safer not to exceed 140 deg C. After bakelizing the coils should be submitted to slow drying so as to expel any remaining traces of moisture or solvents and this operation can be hastened considerably by the use of a vacuum dryer.

In other cases ready wound coils may be simply impregnated with liquid A using the precautions as described for the impregnation of wood. Capillary conditions as described for the wood impregnating process exist here so that with some precaution it is possible to slowly transform A into C or at least into B in an ordinary drying stove without the absolute necessity of resorting to a bakelizer always provided the heating be started at temperatures as low as 60 deg to 70 deg C and gradually increased to 120 deg to 140 deg C.

In fact it may be found sufficient not to go beyond B and leave it to future self heating of the wire when run under overload to arrive at the final condition C.

It ought to be mentioned here that in such coils with many layers of metallic wire the outer shell of B may act as an envelope which insures internal pressure during the heating process just as if it was in a closed vessel and thus prevents dissociation and the resulting formation of a porous mass.

As a modification to above methods I should suggest the following.

The coil after being properly impregnated may simply be put in an accurately made closed mold and the latter may be filled with more A using pressure if required so that after bakelizing the same the whole will come out in accurate size and shape and present a much neater appearance than the ordinary clumsy coils now in use for dynamo and motor construction. The very fact that henceforth it is possible to mold coils in regular shapes and most accurate dimensions may ultimately simplify the construction of this class of machinery and render renewals much easier.

Coating Processes. The simplest way for coating an object with bakelite is to dip it in liquid A and then finish it in the bakelizer. By slightly heating the objects and by using rather thick A the operation becomes rather simple especially for metallic objects. Or the A coated objects may be first heated gently in a stove until the A has been transformed in B and then the object may be transferred to the bakelizer. Several coats may thus be applied in succession until any desired thickness is attained. This method of building up a thick coat by several layers takes away the danger of cracking or splitting when thick coats are applied all at once.

The sudden contraction during polymerization has to be taken into consideration here. There is another way of counteracting the effect of too much contraction namely the incorporation of suitable filling materials as silica or fine sand clay slate dust, powdered asbestos etc. Any of these materials added to liquid A in suitable proportion will give a putty like mass which can be easily kneaded specially if slightly heated. It can be applied and modeled to any kind of surface to the desired thickness and shape. This same mass can be rolled out in thin sheets, and the latter can be applied on the inside and outside of metallic vessels. The whole can be directly finished in the bakelizer or be heated previous at low temperatures so as to bring it first in B state. This method gives a ready means for covering iron pipe or pumps or similar objects with a layer of protective material and thus render them more suitable for chemical engineering purposes. Thick layers of bakelite without filler or mixtures containing little filler do not adhere well to metallic surfaces. But by using more filler and specially by using gritty materials as fillers like sand or abrasives the adherence becomes excellent. For instance mixtures of emery with about 10 to 15 per cent liquid A can be made so that after bakelizing they will stick to glass to the point that they can no longer be removed unless by chipping off pieces of the glass.

A composite coating of bakelite can also be applied on wooden or metallic vessels by first dipping a sheet of asbestos in A partially transform it into B by heating then stick it by means of thick A to the surface which is intended to be protected and after ward press it against the surface by means of a hot smooth plate. The latter operation is finished in about ten or fifteen minutes if the pressing plate is maintained sufficiently hot. By selecting polished metallic pressing plates a very beautiful finish can be obtained at the same time. In this case bakelite not only acts as impregnating and finishing material but also as an excellent and permanent adhesive.

A modification of this method has given splendid results for veneering and finishing wood accomplishing in a few minutes results which heretofore could not be obtained after weeks of polishing sandpapering and varnishing with the older methods as practised by piano and furniture manufacturers.

A similar method may become useful for lining wooden or metallic boxes with impregnated asbestos so as to make them suitable for electrolyzing tanks or storage batteries.

Whenever very thin layers of bakelite have to be applied it may be simpler to use A in alcoholic solution as a varnish, for this purpose dissolved A, properly diluted with three to four times its volume of wood alcohol, is very suitable. This can be done by brushing dipping or spraying. This varnish dries in a few minutes to a point where it is no longer sticky but it may take several hours before it is entirely dry. Even then the last traces of solvent are not expelled entirely and even after years the layer remains A soluble and fusible. If temperatures above 100 deg C are applied we may get nearer the stage C but there is a decided tendency toward blistering especially in such spots where the varnish has been applied rather thickly.

The use of the bakeliser prevents all this, and for wood or other materials which have a porous surface it is entirely indispensable. For metallic surfaces, by using great precaution and thin layers, and by raising the temperature very gradually until it attains 120 deg to 140 deg. C., a hard coating may ultimately be obtained.

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* Paper presented at the Fifteenth General Meeting of the American Electrochemical Society at Niagara Falls, Canada, May 6th to 8th, 1909. See SUPPLEMENTS Nos 1768 and 1769 on Bakelite.

Sheet iron, or stamped boxes provided with a thin coating of bakelite, can stand boiling dilute sulphuric acids and boiling neutral solvents.

It should be borne in mind that on account of the limited flexibility of bakelite, such sheets cannot be twisted or bent beyond certain limits without splitting the protective layer. In any such cases where bending has to be done it must be done before the varnish is applied or after the A has been changed in B which still leaves some scope for flexibility.

Molding Processes. The simplest but slowest way for molding bakelite is to pour liquid A alone or mixed with fillers in suitable molds and heat in a bakelizer. This operation may take as much as one to three hours according to the temperature or the size of the object, so that this process has the objection of requiring the relatively long use of molds. It can be shortened by simply carrying the heating process until the B stage, after which the object can be expelled from the molds and finished in the bakelizer at any suitable time thereafter and without the further use of molds. The B stage can be obtained by plain but slow heating in a stove or water bath or by rapid heating in the bakelizer. But even all this is too slow for many purposes where quick and accurate molding is essential. It then becomes simpler to mold in a hot press. For this purpose a hydraulic press or a screw press or even a lever press can be used as long as it is provided with contrivances whereby the platens can be heated and cooled quickly either by steam and cold water circulation or by gas heating. Temperatures as high as 200 deg. C. are desirable for rapid and best work, but the molding can be done also at 80 pounds steam pressure. It is a noteworthy fact that molds under high pressure contact with the platen heat up and cool quicker than if not under pressure.

I tried first mixtures of liquid A with various filling materials, the mass being mixed between rollers same as are used in the rubber industry, but I found afterward that this slow and expensive method of mixing is entirely unnecessary if solid A be used.

Furthermore liquid A has the disadvantage over solid A of requiring a longer time for molding. Solid A has the great advantage over other plastics in that the first action of heat liquefies it entirely, so that high pressures as required for molding celluloid, rubber or resinous materials are superfluous unless large amounts of filling materials be used which make the mass less plastic. After the first liquefying action of the heat the immediate after-effect is quite contrary, namely the hardening of the mass while A becomes B, then C. The main function of the pressure in the act of molding A is to counteract the dissociation which would cause porosity and resulting lack of homogeneity. This explains why astonishingly accurate molding—for instance talking machine records—can be made with bakelite under low pressure, provided sufficient heat be used. Persons who are familiar with the molding of celluloid, shellac or rubber compositions, when trying bakelite for the first time are apt to heat the molds insufficiently, being under the wrong impression that high temperatures may spoil bakelite in the same way as the compounds to which they are accustomed.

The great penetrating power of A makes it possible of making molded objects containing as little as 10 per cent and even less of bakelite, the remainder being made up of suitable fillers, for instance asbestos.

Quantities of 20 to 30 per cent of solid A and 80 to 70 per cent of asbestos make excellent compositions for molded insulators.

In some cases it may be found desirable to increase the amount to about 40 per cent. Wood pulp or ground sawdust require these larger proportions if the objects have to stand boiling water without losing their gloss.

The mixing of these compounds is very simple work. The solid A is pulverized in a porcelain ball mill, and ground to 50 or 100 mesh. If trouble is experienced on account of the ground material sticking to the walls of the mill, this can be easily obviated by adding about 10 per cent of the filler, which prevents "caking." The so ground A can be kept in reserve for further use. It is then mixed in suitable proportions with the finely powdered filling materials and reground in a ball mill so as to insure thorough mixing. This mixed powder is now ready for molding, on account of its bulkiness it may be found preferable to compact it somewhat by pressing it slightly or rolling it into sheets while being gently heated. The resulting sheets or cakes can be kept in stock. To use these for molding they are put into the slightly heated molds, and the latter are pressed now between the very hot platens of the press, which squirts out any excess of material. Pressing and heating is continued until the A is transformed into B, after which the molds can be emptied. According to the size of the molded objects or the temperature molding is finished in a time varying from twenty-five minutes to three minutes, and even less for small objects.

Molded objects of bakelite in B condition are about as strong as shellac, but they still soften under the influence of heat. They become considerably stronger and acquire their final resisting qualities by being heated in the bakelizer. This final treatment can be carried out at any suitable time, all the pieces being put in together. No molds are needed here because B although soft while hot does not melt any longer and keeps its shape while submitted to the high heat of the bakelizer.

We here observe again a slight shrinkage of volume which has to be taken into consideration while designing the molds. This contraction is always the same for the same compositions and becomes very small if large amounts of fillers are used. By taking these factors into consideration the molding can be done with an accuracy of 0.001 inch or better.

We have stated above that C cannot be molded, it is no longer plastic. In other terms its particles if pressed together do not give a strong coherent mass where all the particles are welded homogeneously together.

On the other hand B, although infusible and insoluble, softens when heated under high pressure and welds and molds together.

This enables us to still further simplify the molding operation by using ground B instead of A. But it then becomes necessary to use maximum temperatures and highest possible pressure, B not flowing so easily as A. This is specially indispensable when large amounts of filling material are employed. This method of working is decidedly advantageous when a highly polished surface and very accurate molding is desired. By keeping long enough in the mold no after-treatment in the bakelizer is required, and the gloss imparted by a polished mold is thus kept intact. The use of B is also advisable in such instances where mixtures rich in bakelite are desired. Whenever mixtures are made containing over 40 to 50 per cent of A there is constant danger that during the act of molding the A may ooze out before it has had time to be changed into B. By using directly B this difficulty no longer exists and there is no further limit to the quantities which may be employed in a molding mixture.

For such molded electric insulators which are expected to stand high temperatures, finely ground asbestos, clay, mica or other similar mineral fillers should be used. If temperature specifications are not so important then organic fillers like wood pulp or ground sawdust are available and give nicely molding compositions of which the insulating coefficient is frequently considerably higher than that of asbestos. Some varieties of Canadian asbestos prove to be much less desirable for high voltage insulation; this is probably due to *mineral impurities and to the higher* content in water. These differences in insulating properties do not play much importance for voltage below 40 000. On the other hand asbestos on account of its fibrous texture lends great strength to bakelite compositions and makes them stand better the shattering effect of direct impact or concussion.

The difference in insulating properties of asbestos is clearly shown by comparing results with a sheet of blotting paper impregnated with bakelite and of asbestos paper of the same thickness treated in the same way. The impregnated blotting paper may puncture at voltages two and three times higher than the asbestos sheet.

Bakelite compositions lend themselves more or less to kneading, filing and sawing, according to the nature of the filler. In this direction compositions containing fibrous materials show again the best results.

I have stated before that bakelite alone can stand 300 deg. C. but compounds which contain large amounts of mineral filler may be made to stand even higher temperatures. Those containing wood pulp, sawdust or other organic fillers will stand less, the filling material being destroyed before bakelite.

It is a well-known fact that whenever rubber is used as an insulator it slowly emits sulphur vapors which by and by attack metallic parts and may cause serious injury to delicate copper wires or metallic connections. Bakelite not emitting any such objectionable emanations does not possess this defect, and therefore has been preferred in the manufacture of delicate electrical instruments.

But I have not yet mentioned another advantage of bakelite insulators over those made of shellac or other resinous materials.

It is a known chemical fact that the latter are all apt to hydrolyze by the action of water or dilute alkalies. This action is readily shown whenever water is dripped on a table varnished with shellac, which causes whitening on the wet spots. This effect is more pronounced whenever a small amount of ammonia is present. A similar action occurs whenever the conditions of the atmosphere deposit a thin film of moisture on shellac insulators, so much the more as the air always contains traces of ammonia. This superficial hydrolysis, which forms on the surface of resinous insulators a thin film of conductive chemically changed resin, may explain the so-called "creeping" of high voltage current along the surface of resinous insulators. The very fact that bakelite can be heated in presence of water and ammonia in an autoclave at 200 deg. and over without hydrolysis makes us feel safe as to its resisting power to atmospheric influences.

Whether bakelite-asbestos or bakelite-mica insulators will answer the purpose for high voltage insulation as well or worse than porcelain is a matter which experience and the test of time alone can decide.

For insulation in third-rail systems where continuous vibration of passing trains plays havoc with brittle and unreliable porcelain, bakelite-asbestos has indicated decided superiority after several months of continuous service as well as by direct laboratory tests.

ELECTRICAL TESTS

No	Name of Piece	Bakelite	Remarks
1	Spool	Punctured at 16 000 to 18 000 volts	Asbestos hard rubber composition punctured at 4 000 to 8 000 volts
2	Square tube (hollow) thickness 0.10[illegible] inch	Punctured at [illegible]1 000 volts	Asbestos hard rubber composition punctured at 1[illegible]000 volts
3	Washer thickness 0.0[illegible]2 inch	Punctured at [illegible]0 000 volts	Asbestos hard rubber composition punctured at 11 000 volts
4	Disks of various compositions Thickness 0.08[illegible] inch Thickness 0.16[illegible] inch Thickness 0.105 inch Thickness 0.1[illegible] inch	 Punctured at 4[illegible] 000 volts Punctured at [illegible]1 000 volts Punctured at 22 000 volts Punctured at 12 000 volts	These tests are still [illegible] and were made [illegible] bakelite compositions [illegible]
5	Disk Thickness 0.0[illegible] inch	Punctured at 18 000 volts	Asbestos hard rubber composition punctured at 1[illegible]00 volts
6	Cup insulator Thickness 0.[illegible] inch	Punctured at 4[illegible] 500 volts	
7	Line insulator	Arc over [illegible] at 50 000 volts	Tested on 11 500 volt line
8	Rail insulator	Resistance dry 5.6 megohms Resistance wet 0.[illegible] to [illegible] megohms These tests are only approximate in megohms Arc over [illegible] bolt to rail 2[illegible] 000 volts	Porcelain resistance dry [illegible] 50 megohms wet 0.2 to 10 megohms Porcelain arc over [illegible] volts

MECHANICAL STRENGTH TESTS

No	Name of Piece	Bakelite	Remarks
[illegible]	Square tube (hollow) thickness 0.1[illegible] in	Traverse strength 6-inch centers 1 850 pounds Ultimate strength compression 90 000 to 110 000 pounds	Asbestos hard rubber composition 1 700 pounds Porcelain 4[illegible] 000 to 8 000 pounds
8	Rail insulator	Ultimate strength tension 3,300 to 5 800 pounds Impact test no limit found for same blow as porcelain was submitted to	Porcelain 1 400 to [illegible]00 pounds Porcelain 8 to 10 blows
9	Cup piece hollow cylinder 3 inches high 1¾ inches diameter 0.045 inch thick	Ultimate compressive strength 2 [illegible]50 pounds	[illegible]

HEAT TESTS

No	Name of Piece	Bakelite	Remarks
10	Valve interior	At 2[illegible]5 pounds steam about 400 deg Fahr for one hour	No effect on the composition
11	Packing nut Graphite composition	Tight at [illegible] pounds, steam 300 r p m	Could turn [illegible] shaft [illegible]

NOTE All of the bakelite insulation shows an unusual uniform resistance at varying temperatures from 0 deg to 100 deg Centigrade, and does not soften at much higher temperatures. Most of the insulation contained about one third bakelite and two thirds finely divided asbestos.

besides greater strength it has shown more regularity in manufacture and allows more accurate molding which permits closer designs and smaller margin of safety

There is no difficulty whatever in imbedding metallic parts like bolts cores screws washers or reinforcing members in the molded mass

In the tables are condensed some comparative results which have been communicated to me by users of bakelite who previously had acquired great skill in the manufacture of other excellent insulating compounds and by this fact were better able to draw comparisons

Before leaving this subject mention should be made of the properties of special mixture of bakelite with graphite of which I have here some specimens Both these materials compound very well together in almost any proportions Liquid A or solid A can be used for this purpose By varying the amounts of bakelite these compositions may be made of varying hardness from such ones as write on paper like the soft lead pencils to others which are so hard that they no longer leave a tracing when rubbed against a rugous surface I do not know in how far this may be utilized in the pencil industry but I have obtained some very encouraging results by trying to use them for self lubricating bearings The fact that such bearings can be molded very accurately at little cost makes their interchangeability and rapid renewal a very easy matter Dynamos or motors or other rapid revolving machinery where lubrication is a delicate matter might be provided with such bearings instead of the older metallic bearings Bakelite graphite bearings will not melt nor soften in case of overheating they can be used in conjunction with oil like any other bearing and in case of insufficient supply of oil the graphite present will supply the necessary lubricant

As a lining for pumps which are required to handle liquids which corrode iron this same mass may find its uses

But bakelite graphite composition presents other possibilities from an electrical standpoint It namely gives us a means of producing a material of which the electrical resistance can be changed at will in a very wide range by changing the proportion of bakelite

Finally I might mention that I have tried to decrease the porosity of graphite anodes in electrolytic cells by the injection of extra thin liquid A and bakelizing afterward but although in a first experiment we were able to decidedly decrease anode corrosion I am not sure whether this was due to direct action or to a somewhat lessened conductivity This may be a suggestion for Dr Turrentine in his experiments with graphite as *electrodes for electrolytic* analysis

SCIENCE NOTES

In order to eliminate all danger of infection from dirty milk bottles and to place the distribution of whole milk on a strictly sanitary basis the New York Milk Committee in its seven infants milk depôts is using for the first time in New York city a single service paper milk bottle which it instructs its patrons to throw away as soon as it is emptied of milk

It is expected that aluminium coins of low value will be in circulation in France by the end of this year It is interesting to note in this connection that the adoption of M Naquet's proposition for an aluminium coinage in 1871 would have resulted in a heavy loss to the French Treasury Although experts declared it to be impossible that the value of the metal should decrease it has now fallen to nearly half the price ruling thirty eight years ago

An article in the Genie Civil states that seventy eight electric furnaces now exist in the steel works of the world of which thirty five are on the induction and forty three on the arc principle Fourteen are Kjellin furnaces eleven Stassano ten Rochling Rodenhauser three Elektrometall Society (Sweden) and one each Colby Hiorth Keller Schneider and Wallin There is a steady and marked tendency to increase the capacity of these furnaces some of those already constructed holding as much as eight to ten tons

Measurements and estimates from mariners and observers at sea indicate that the average height of all the waves running in a gale in the open ocean is about 20 feet but the height of the individual waves is often found to vary in the proportion of one to two and there is in fact in a fairly regular sea a not inconsiderable range of size among the waves In any statement that we may make as to the size of waves in a gale on the ocean we should not neglect the mention of the larger waves that occur at fairly frequent intervals These which may be termed the ordinary maximum waves are perhaps what seamen really refer to when they state the size of the waves met with during a storm at sea About 40 feet is a common estimate of the height of the larger waves in a severe gale on the North Atlantic and this estimate is really not incompatible with a recorded average of a little more than 20 feet It is difficult to say what may be the greatest height of the solitary or nearly solitary waves that are from time to time reported by mariners The casual combination of the numerous independent undulations running on the sea presumably sometimes produces two or three succeeding ridges or two or three neighboring domes of water of considerably greater dimensions than those of the ordinary maximum waves of a storm Although these large cumulative waves may be frequently produced yet they will be comparatively seldom observed because so small a fraction of the ocean's surface is at one time under observation There are seemingly reliable accounts of cases in which these topping seas have reached the height of 60 feet

ENGINEERING NOTES

From a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the Bessemer type it is noted that the wear on the former showed 1 4[illegible] pounds per yard as against 4 18 pounds per yard on the latter which is nearly 300 per cent in favor of the new alloy steel

Rain gutters at the eaves and headers have been dispensed with in the buildings of the new Scranton locomotive shops of the Delaware Lackawanna and Western Railroad thus doing away with the numerous troubles experienced with them The roofs project about 12 inches beyond the walls and the drippings are caught in a monolithic concrete gutter at ground level which is sloped to perforated drain covers placed at convenient intervals The gutter is a dished slab molded in place against the building

The smelter production of lead in the United States in 1908 as given by C E Siebenthal of the United States Geological Survey under the date of May 24th was 408 [illegible] tons of 2 000 pounds against 442 015 tons in 1907 and 418 699 tons in 1906 The production of refined primary lead which embraced all desilverized lead produced in the country and the pig lead recovered from the Mississippi Valley lead ores was [illegible] tons against 414 18[illegible] tons in 1907 and 404 669 tons in 1906 The antimonial lead produced was 13 629 tons and the recovered or secondary lead 18 283 tons In 1908 the lead smelted from domestic ores was 310 762 tons and from foreign ores and foreign base bullion—almost wholly Mexican—97 761 tons

Experiments with concrete telegraph poles by the Pennsylvania Railway have met with such success that the executive officials of the line have decided gradually to extend their use over the Fort Wayne Panhandle and other lines west Before many months it is possible that old wooden poles along the lines in that vicinity will be replaced by concrete No definite sum of money has been put aside for this purpose but it is understood that the engineering department has been given orders to prepare to use concrete poles The instruction and improvement programme for 1910 which will be decided upon shortly is expected to include orders to place many miles of concrete poles on the lines west

During the first half of the last century it was solid fuel only that was employed for the generation of heat and power but the last half of the century has seen the advent of liquid and gaseous fuels which under certain conditions proved themselves of the greatest value and certain processes are now largely dependent upon their use this being due to the ease of application which has meant economy in labor and greater facility for converting the heat into work As an example of the ease of application making a fuel of poor calorific value more effective in use than coal of high quality one may instance such manufactures as those of glass where in the heating by solid fuel the necessary temperature had to be imparted to the mass of raw material through the walls of a thick fireclay retort the difficulty of application here being dependent upon the fact that the crucible had to be heated to a very high temperature to get the necessary fusing point of the glass mixture and that maintaining this for a considerable period meant a big expenditure in fuel and great wear and tear to the furnace and containing vessel It was clear that if the fuel could be gasified and the clean flame made to play directly onto the surface of the mixture to be fused instead of having to impart the heat through the walls of the containing vessel an enormous economy would be obtained and this is now done by the utilization of producer gas and regeneration in the continuous tank process In the same way liquid fuel as soon as methods could be found for its proper combustion presented such wonderful economies and advantages for marine work that in spite of its being dearer than coal it at once found a place in both the navy and merchant marine The possibility of being able to store it below the level of the boiler in the ballast tanks instead of having as in coal bunkers to have the storage above that level at once gave increased space in the important part of the vessel and, what was of much greater importance in the service the being able to carry a larger supply of latent energy in the same space as the coal occupied increased the radius of action of the vessel

ELECTRICAL NOTES.

The United States government have issued returns as regards telegraph and telephone systems in the country, and from particulars published by the Telegraph Age it would appear that there are 65 miles of wire in the Republic of Panama 484 miles in Puerto Rico, 1 403 miles in Alaska and 6 438 miles in the Philippines These systems handled over 1 000 000 messages The Weather Bureau controlled 537 miles of wire and 96 miles of submarine cables and 2 280 places, were supplied with forecasts 734 with special warnings and 5 998 with emergency warnings all this being done at the expense of the government Daily forecasts were sent to 2 141 151 addresses Puerto Rico boasts of 128 offices and 1 774 miles of wire and the traffic amounted to 216 489 messages

As a result of the active agitation which has been carried on for some time in favor of the compulsory conversion of all steam railways entering the city of Chicago to electric traction states Electrical Engineering the City Council have drawn up an ordinance requiring all railways within eight miles of the city hall to adopt electrical power after January 1st 1912, in accordance with plans approved by the Commissioner of Public Works There is considerable opposition on the part of the railway interests but the city officials consider the legality of the ordinance unquestionable The ordinance has yet to be reported on by the committee on local transportation but in the opinion of our contemporary there is every likelihood of its being finally carried

Some electric motor coaches are being built for suburban service on the New York New Haven & Hartford Railway These cars are designed to operate on both the 11 000 volt alternating current overhead system used on the main line and on the 600 volt direct current third rail section used near the New York terminus The cars are intended to pull trailers and are equipped with four series compensated motors These and the step down auto transformers are supplied with forced ventilation from the blower system When the equipment is operated under forced ventilation the one hour rating of each motor is 200 horse power Each car is guaranteed to haul two 50 ton trailers and when so operating will accelerate normally at a rate of 0 7 mile per hour per second

In a recent issue of the Electrical World a patent issued to Mr B Frankenfield is described The claim relates to an arrangement whereby the load on several shunt wound direct current motors connected in both mechanical and electrical parallel can be divided equally among the machines Each motor is provided with as many separate field coil sections as there are individual motors the sections on one machine being joined in series with those on the other machines The arrangement is such that any change in the field circuit resistance of one machine varies the strength of the fields of all the machines equally This action prevents any motor from taking more than its share of the load as would be the case if the motors were independently connected to the supply system and the field winding of one became hotter and therefore admitted less current than the field winding of another motor

A detailed study of the lengths of the waves emitted by many of the ordinary forms of generators of short electric waves has been carried out by Messrs H W Webb and I E Woodman at Columbia University and the results are given in the August number of the Physical Review The object of the authors was to establish such definite relations between the dimensions and electrical properties of the generators and receivers of the waves as to enable future workers to calculate the wave length with certainty from the dimensions of the apparatus used The method employed was Boltzmann's the beam sent out by the generator being reflected at two mirrors and the two half beams brought together to produce interference Rod cylinder Righi and other generators were tested and the wave length measured in each case a non selective receiver being used For apparatus of the same type but of different size the wave length is proportional to the linear dimensions of the apparatus

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AN ELECTRIC DREDGER AND LOCOMOTIVE

By Frank C. Perkins

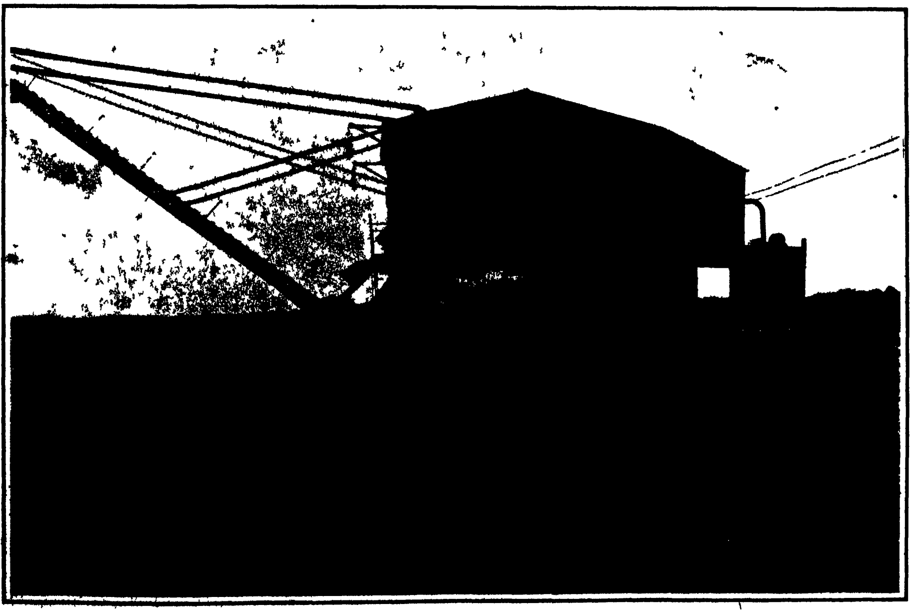
A most interesting electrically operated dredger at the German Marga lignite mine of the Isle Bergbau Aktien Gesellschaft has been installed by the Siemens Schuckertwerke of Berlin The lignite lies near the surface but is covered with a layer of earth which has to be removed Electric locomotives are provided to haul dump cars to and from an electric dredger of the bucket type utilized for loading the trains

The Abraumbahn operating at the Marga mine and at the Kauscherwerk near Petershain N L is provided with two large locomotives of 250 horse power and 350 horse power capacity respectively and a smaller electric locomotive of 60 horse power capacity

The overhead trolley construction of the Abraumbahn at the Braunkohlenwerk at Petershain may be noted in one of the illustrations the overhead conductors being placed from 8½ feet in height at the electric bucket dredge to 13 and 16 feet along other portions of the railway

It is stated that by the use of the electric locomotive and electric dredge a saving in labor of six to ten

ELECTRIC LOCOMOTIVE HAULING A TRAIN OF DUMP CARS ON THE ABRAUMBAHN



THE LARGEST OF THE ELECTRIC LOCOMOTIVES EMPLOYED IS TO BE SEEN UNDER THIS LIGNITE DREDGER

A GERMAN ELECTRIC DREDGER AND LOCOMOTIVE HAULAGE EQUIPMENT engineers and firemen was effected with greater output than could have been produced with steam locomotives and a steam operated dredger The current for operating the electric dredge as well as the electric locomotive is supplied from a three phase high tension power transmission line a transformer station lowering the pressure and changing the current to a direct current of from 0 to 600 volts The large double truck electric locomotives noted under the electric bucket dredger at Petershain in one illustration and as seen in the other illustration hauling a train of loaded dump cars at the Marga rain weigh [illegible] and 14 tons respectively and are equipped with four motors connected in two groups and arranged to be connected in parallel or in series to provide two different speeds The normal speed of these locomotives [illegible] miles an hour They are equipped with both hand and air brakes and air operated sanding devices The total height of the locomotives is only 8 feet in order that they may readily clear the bucket dredger

The smaller locomotive is also used at the Kauschwerk at Petershain and has a capacity of 60 horsepower It is provided with two pairs of driving wheels having a motor on each axle Each of the two electric motors has an output of from 26 to [illegible] horse power and is supplied with current of 500 volts pressure There is a larger electric locomotive in service at the Kauscherwerk near Petershain on the Abraumbahn which weighs 28 tons and has a capacity of 240 horse power, four motors of 60 horsepower each one motor being provided on each of the four driving axles and arranged in two groups for parallel and series operation The drawbar pull of the electric locomotives is said to be 33 per cent of their weight while with steam locomotives the drawbar pull is only 22 per cent.

WIRELESS SIGNALING IN AERONAUTICS.

EXPERIMENTS OF THE SIGNAL CORPS.

BY F. H. McLEAN.

Through one or another of its branches the United States government has taken up wireless telegraphy experiments *via* both kites and war balloons and public and private interests all over the country are energetically trying to combine wireless telegraphy and practical sky craft If airships balloons and kites can be made to serve successfully as portable stations for wireless telegraphy their value both in time of war and peace will be immeasurably increased Wireless telegraphy will also be enabled to add further advantages to its already numerous points of superiority over all other forms of communication

The United States Signal Corps so far as is known, is in advance of all foreign military bodies in its invasion of this field but while the American army officers early realized the many advantages that would accrue if war balloons could be utilized as wireless stations there were several obstacles to be overcome before practical experiments could be accomplished The most important one was the weight of a standard wireless apparatus of sufficient power for the exchange of messages between the ground and a war balloon at a lofty height This obstacle has been overcome in a portable wireless set which has recently been designed by Signal Corps experts the first example of which has just been completed at the Signal Corps shops in Washington under the direction of Electrical Assistant H B De Groot

This compact little wireless equipment not only conforms to the requisite of minimum weight but it solves the other chief problem presented in this new field which was the provision of safeguards against a spark from the telegraphic apparatus igniting the explosive gas that through design or accident might escape from the bag of the balloon Among electricians there is a difference of opinion as to what danger of explosion would exist under normal conditions Although some experts contend that there would be practically no danger on account of the air currents created by a balloon in motion, the United States army aeronauts recognizing the tragic consequence that would surely follow such an explosion at a high altitude have been loth to take any such chances and have had every precautionary measure taken in the construction of the apparatus designed for their experimental work

The weight of this wonderful new aerial set all told is only about 70 pounds and it occupies or rests upon a wooden frame of special design which measures [illegible]0 inches in length 17 inches in width and 1[illegible] inches in height The electrical energy for this cloud climbing telegraph station is supplied from an ordinary 8 volt sparking battery similar to those used in automobiles The part of the equipment weighs but 22 pounds as compared with a weight of [illegible]0 pounds in the corresponding section of the lightest portable wireless set that would have been available for this work had not the army experts evolved this special apparatus To guard against the explosions explained above the spark gap has been covered so as to exclude all gas and there is a similar protection for the interrupter contact For all that this latter essential is housed in it is always within view of the operator by means of a small mica window in the side of the case and with the view of the contact thus available any necessary adjustments can be made without opening the case This new wireless set for military work in the clouds has the same type of key and telephone receivers found in the portable wireless sets which have lately made their appearance in the commercial field A thoroughly unique feature is the aerial from which the sound waves are sent on their long journey The aerial devised for wireless telegraphy *via* the scouts of the sky consists of three wires each 1[illegible]0 feet in length suspended from a cross arm attached beneath the keel or car of the balloon It will be understood that these wires dangle below the cloud clipper and thus the incoming messages instead of being caught above the station as in all earthly installations will be caught below the station In lieu of a ground wire the aerial telegraphers will make use of the wire netting which braces the balloon car The cost of this wireless set was about $[illegible]00

The first experiments of the army with wireless telegraphy *via* aerial craft were made with an ordinary spherical balloon The new wireless set just completed was designed primarily for use with the United States army dirigible No 1 lately acquired by the War Department When in service the wooden platform carrying the electrical apparatus rests across the keel or skeleton framework of the balloon being supported upon the two horizontal rods of the keel The dirigible which is destined to serve as Uncle Sam's first portable aerial wireless station is 120 feet in length and the car or keel which carries the wireless apparatus is made of spruce and is 60 feet in length by 2½ feet in width and 2½ feet in height The balloon which is equipped with a 20 horse power motor has a speed of 20 miles per hour and a lifting capacity of 1 350 pounds of which [illegible]00 pounds are available for passengers ballast and fuel

The electrical division of the United States Signal Corps has been busy with plans for wireless work *via* free balloons that would prove of great value in times of war but while they have been thus employed another branch of the Federal government has been looking into the possibilities of midair telegraph stations designed to serve the pursuits of peace Chief Willis Moore and his associates of the United States Weather Bureau have long taken a very keen interest in this subject and experiments covering high air work with both balloons and kites have been in progress for some time past at Mount Weather in Virginia sixty miles from Washington On this mountain peak the Weather Bureau has assembled a marvelous equipment for the exploration of the upper air The primary interest of Prof Moore in wireless telegraphy is as a means of transmitting storm warnings and weather forecasts particularly the interchanges at sea between ships and shore stations He is also convinced that this new communicative force has a rich future in certain other directions for instance in life saving work and in all such spheres the use of kites or balloons to carry aloft the terminal wires would immensely increase the radius of action of the wireless system

Wireless telegraphy *via* kites superseded by many years wireless telegraphy as we know it at the present time Forty years ago Mahlon Loomis a resident of Washington announced that he had solved the problem of transmission without wires by means of raising kites to great altitudes and telegraphing between them and he claimed to have transmitted messages a distance of more than four hundred miles At the time the interest in his work was so great that Congress passed a special bill authorizing the incorporation of a company to continue and extend the experiments but the project came to grief in the panic of 1873

The development of wireless telegraphy has again turned attention to the possibilities of the use of kites as sending and receiving stations and it has been demonstrated that kites have exceptional qualifications for such functions When a kite is flown at a great altitude a strong current of electricity is generated especially when the kite is flown by wire instead of by cord At Mount Weather where piano wire is used so strong a current is brought down from the clouds that it has been necessary to insulate the reel on which the wire is wound This presence of the magic current in force is manifest even on clear days when there is no sign of an electrical storm Experiments are now in progress with a view of using this captured current for wireless telegraphy Telegraph instruments are cut in on the kite circuits and a test is to be made as to the possibility of communicating between two kites flown at points located sixty miles apart

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REDUCTION GEAR FOR STEAM TURBINES

The great drawback to the rapid adoption of the steam turbine to ship propulsion is the high speed at which the propeller has to revolve Marine engineers have long been looking for a satisfactory and economic method of obtaining a lower propeller shaft speed than that given by directly attaching the screw to an extension of the turbine shaft and many suggestions have from time to time been put forward to overcome this objection

Those hitherto received with the greatest favor are based on the electric transmission of power but it has been difficult to convince parties concerned that the total loss due to conversion would be lower than the loss of the efficiency of the screw at high speeds let alone the introduction of machinery with its liability to break down and increase of weight

According to The Times the problem has been solved that paper reproducing a pamphlet received from Mr George Westinghouse entitled Broadening the Field of the Marine Steam Turbine The Problem and Its Solution and containing a description of the Melville and Macalpine reduction gear

According to this document the end has been accomplished by means of a helical reduction gear after that used in the De Laval turbine but suited for the transmission of the highest powers The wheels are in duplicate with the spirals running in opposite directions thus balancing the thrust The smaller gear is mounted on a floating frame which has the effect of securing an equal pressure over the whole of the bearing surface of the teeth or gear

The efficiency of transmission on a 5 000 horse power turbine running at 1 [illegible]00 revolutions per minute is stated to be 98 5 per cent from which it is calculated that in the case of a vessel such as the Cunarder Mauretania the effective thrust would be obtained at the propeller with a reduction of 15 per cent on the steam consumption This is derived from the supposition that the efficiency of the propellers at present is about 55 per cent while propellers designed for the lower speed would have an efficiency of not less than 6[illegible] per cent Incidentally the coal consumption would be decreased in proportion the cargo-carrying capacity would be increased and there would be a considerable reduction in labor and upkeep

The advantages of the new system in connection with naval vessels are touched upon We hope however to be able to acquaint our readers with some interesting details of this form of reduction gear as designed for the transmission of heavy power at no distant date

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It is reported that a large wireless telegraph and telephone station is to be erected at the Omaha shops of the Union Pacific Railway, where Dr Frederick H Millener will conduct wireless telegraph and telephone experiments Dr Millener hopes to develop wireless telephony to such an extent as to permit railway officials to keep in touch with trains, and thus govern their movements from sixty to one hundred miles from Omaha If the system is developed as he expects it will be possible for passengers on moving trains to carry on telephonic conversation within a radius of one hundred miles from Omaha.

ILLUMINATING ENGINEERING.

THE TECHNIQUE OF ARTIFICIAL ILLUMINATION.

The phrase "illuminating engineering is of comparatively recent origin We believe it is American Although not particularly euphonic it will perhaps serve as well as another to indicate a sphere of work which is certainly a branch of engineering and is probably of sufficient importance to justify its claim to be considered as an independent entity As we understand it the illuminating engineers claim the whole field of artificial illumination as their sphere They point out that up to the present problems of illumination have been left to the arbitrament of engineers or others specially interested in some one of the various systems of lighting or have been treated as of little importance and dealt with in a haphazard or careless fashion They claim that it shall be their special business to deal with such problems and weighing without prejudice the advantages and disadvantages of the various systems to recommend the most suitable for each particular place or circumstance Further studying the subject they will be competent to advise on the size and position of lights on their character on the color of walls and on other attendant matters so that each particular installation may obtain the most suitable and efficient system for the expenditure involved They also point out that many data are available relating to the distribution of l as been undertaken at one time and another so that much data is available relating to the distribution of light the effect of color and kindred matters It shall be their business to coordinate and extend these data build up a rational practice and evolve rules dealing with the amount of light necessary for particular positions or purposes

Progress in the art of artificial illumination during the last fifteen years or so has been remarkable This progress has not however been brought about by impartial investigators or illuminating engineers weighing the merits of acetylene against those of petroleum or of gas against electricity It has rather been brought about by the extremists—the men who from prejudice or business interest have concentrated their attention on one or other form of lighting and have struggled to improve its mechanisms and applications so that it could better compete with its rivals in the field Strictly speaking the illuminating engineers do not claim that improvements and future progress will necessarily come from them Their field is the improvement of applications None the less on an average one may expect the general progress of an art apart from radical departures to come from the specialists in that art This is a small point but helps to throw doubt on the supposed necessity for any such body of illuminating engineers In view of the remarkable progress that has been made without them it becomes questionable if there is really any unoccupied field waiting their attention and it is doubtful if any such professional body will really grow up

We doubt if the question of rational illumination is as complex as the illuminating engineers would have us believe In a large number of cases at the present time perhaps in the majority lighting is certainly carried out in an unsatisfactory way Frequently the only criteria are the size of the lights and the size of the room so many 16 candle power lamps for such an area quite irrespective of the color of the walls the nature of the furniture or the purpose for which the room is to be used None the less the treating of such matters in a rational manner is after all a simple question and we are inclined to think that some rough general rules as to the candle power per square foot required for given purposes together with working information on the reflecting power of various surfaces and the distinction between diffused and indirect lighting will in a year or two be commonplaces with those interested in any way in artificial illumination No doubt the spread of this information will be much assisted by the illuminating engineering societies and in this way they may do much useful work None the less the matter with which they are dealing is a simple one and the information they are able to disseminate is likely to be collected and utilized by architects house decorators and others who would never dream of calling themselves illuminating engineers The satisfactory lighting of say a concert hall is child's play compared with the difficulties of adequately heating or ventilating it

There are at the present time distinct signs of a growing appreciation of the more important underlying principles of illumination among those responsible for lighting work This appreciation has grown up as a sort of by product of the great development in the number and efficiency of illuminating systems Manufacturers of special appliances or of new departures have been led to investigate the real advantages or disadvantages of their systems and advertising the former have led opposition manufacturers to attempt to minimize such advantages by bettering them None the less much educational work still remains to be done and the illuminating engineering societies have a large field for the propagation of their doctrines There is still far too much attention concentrated on the question of candle power and far too little on that of illumination Candle power is of course a good selling feature in lamps what salesmen call a talking point and one cannot be surprised that it is kept so prominently before buyers But apart from this tendency to fix attention on questions of candle power purely as a matter of business there are many signs of a growing appreciation of the fact that the really important matter is illumination and not light at all Much credit for this better understanding must be given to the early work of Sir William Preece and Mr Trotter with portable street photometers

There is no question but that great advances in artificial illumination are still to come For the moment the most hopeful field would appear to be in the direction of a more deliberate employment of selective radiation with its attendant increased efficiency In one sense all sources of artificial light are chosen from the point of view of selective radiation No man employs a peat fire to illuminate his house because in the spectrum of a peat fire so much of the energy lies outside the visible range in the low frequency heat rays that it forms an abnormally inefficient light producer In the sense that all sources of light are chosen so that their spectra show a reasonable proportion of the rays lying within the visible range all lighting may be said to be by selective radiation But as Dr Steinmetz has pointed out there is no sense in talking about selective radiation unless we say exactly what we mean by it His definition of a body giving selective radiation is one in which the intensity of radiation throughout the spectrum is distributed differently from that found in the spectrum given by a theoretically black body In this sense a Welsbach mantle gives selective radiation The spectrum is continuous but the intensity is high in the greenish yellows and the efficiency of the mantle as a source of light is consequently high It is possible however to find sources of light which give spectrum lines or bands of abnormally high intensity with a marked absence of the colors corresponding to other rates of vibration The mercury vapor lamp is a case in point Sources of light of this type naturally have marked color and depart seriously from a white light standard Selective radiation of either of these types is suitable for artificial illumination The spectrum band type will normally be the most efficient since the Welsbach mantle type of continuous spectrum contains a large amount of low periodicity radiation which is useless for illumination The spectrum band type will however be useless for many purposes owing to its marked color

It is usually supposed that a white light approximating to daylight should be aimed at in illuminants lamps however giving a light of this kind cannot be the most efficient since the light of one part of the spectrum is always most efficient for any specific purpose Further it is doubtful if the public really desire a white light they are used to artificial lights of the yellowish variety and for indoor lighting especially when the feminine part of the population has to be pleased it is probable that warmer lights of the yellowish red variety will always be preferred above any approximation to daylight None the less extreme color as in the mercury vapor lamp is objectionable Owing to the almost complete absence of low periodicity radiations of little illuminating power in this lamp it is the most efficient light we have but its color or rather its absence of color renders it unsuitable for most purposes It is valuable for situations in which light and light only is wanted or for places in which its peculiar appearance is an advantage such as the outside of a music hall but one has only to conceive the effect of such a light running amuck in a ballroom to realize its limitations Although the mercury arc is the extreme case the comparatively limited color range of the flame arc is sometimes a disadvantage We remember a case in which a flame arc deficient in reds placed in a greengrocer's shop was ultimately rejected owing to the unripe appearance of tomatoes in its light No doubt there are a great many other similar cases

All incandescent solid bodies give continuous spectra so that for selective radiation in the extreme sense we must look to vapor lamps of one sort or another The common examples are the mercury and flame arcs Up to the present no success has attended efforts to modify the color of the former By combining the light given by a mercury vapor lamp with that given by a metal filament or a Welsbach mantle a fair approximation to white light is obtained but such combinations are inconvenient and have been little used The flame arc offers a more hopeful field By varying the impregnating material a fair range of color may be obtained and it is quite possible within limits to select a composition giving a continuous spectrum over a useful part of the white light range with comparative darkness above and below Future developments are likely to take place along these lines and lamps or carbons for specific purposes will probably be manufactured We hardly expect such refinements as the introduction of carbons specially suited to the complexion of tomatoes but a certain specialization in this direction will probably be seen The light most suitable for a foundry is by no means necessarily equally suited for street illumination or for lighting a park or other place where there is much vegetation

The development of lighting and the spread of information in reference to it will probably result in certain definite degrees of illumination becoming recognized as necessary for special purposes Professor Silvanus Thompson in his able presidential address to the newly formed Illuminating Engineers Society on the 18th inst stated that a regulation is in force in Holland calling for an illumination of 10 to 1 candle meters in factories It is likely that some such definite rule will in time take the place of the present unsatisfactory adequate illumination of our own factory rules Prof Thompson also pointed out the importance of this matter in reference to schools but confined his attention and criticism mainly to the question of the size of windows and the amount of light on the desks during the daytime Certainly the daylight in a school is more important than the artificial illumination but the fixing of any standard is obviously much more difficult Any photometric readings taken in the daytime must be so dependent on the weather and state of the sky that obviously any rules which are made must be so broad that in the long run they are likely to be of little more value than the mere demand for adequate illumination to which he objects—Engineering

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ELECTRO-ACOUSTIC METHOD OF MEASURING DISTANCES AT SEA.

MR DEBRIX, an American electric engineer, has according to Cosmos invented an ingenious method of measuring the distance of a vessel which cannot be seen because of darkness, fog or intervening objects This method is based on the difference between the velocities of sound and Hertzian waves

At the receiving station, which we may suppose to be a lighthouse or semaphore station on the coast, a train of clockwork causes a pointer to move over a divided dial at the rate of one division per second The clockwork is started by a Hertzian wave, which is sent out by the ship simultaneously with a sound wave produced by a gun siren or whistle As the propagation of Hertzian waves is practically instantaneous the pointer may be regarded as starting at the instant at which the sound wave leaves the ship The observer on shore watches the pointer and notes its position at the moment the sound reaches his ears The distance of the ship is then obtained by multiplying the number of divisions traversed by the pointer by the velocity of sound (about 1 100 feet per second)

The position of the ship can be determined with greater precision if the Hertzian and auditory signals are received by two shore stations which can communicate with each other by telegraph The distance of the ship from each station having been found the ship's position on the chart will be at the intersection of two circular arcs drawn about the stations as centers with radii equal to the two distances The result might be communicated to the ship by wireless telegraphy

A still better plan would be for each of the chain of coast stations to emit at regular intervals simultaneous Hertzian and auditory signals (the stations being distinguished by peculiarities in the signals as lighthouses are now differentiated) Then any ship provided with the simple receiving apparatus described above could determine its position at any time and make its way safely to port

SUGAR MAKING.

THE CONTINUOUS DIFFUSION PROCESS.

BY H ROUSSET.

The production of sugar and alcohol form one of the principal industries of France and the value of the products obtained yearly from the sugar beet exceeds that of the annual production of iron or coal The processes of sugar making have attained so high a degree of perfection that 90 per cent of the sugar contained in the raw material is recovered and the lump sugar which is sold in the shops is as pure as any of the chemically pure products of special laboratories

The first operation to which the washed and chopped beets are subjected consists in dissolving out of all their soluble ingredients The saccharine liquid thus obtained is purified and from it is extracted sugar or after fermentation alcohol

Nearly half a century ago the old method of extracting the juice by pressure was replaced by the process of diffusion in which the chopped beets are successively treated with solutions each of which contains less sugar than the preceding In other words the water first comes in contact with the most nearly exhausted beets and the weak syrup thus produced is gradually strengthened by contact with less and less exhausted beets until it reaches the fresh beets which still contain all their sugar The process is conducted in a diffusion battery of 1 or 16 cylindrical sheet iron vessels which are arranged in a circle or a straight line are periodically filled and emptied by the operation of numerous cocks which control a very simple system of pipes Without entering into detail it is evident that the operation of such an apparatus involving periodic flow of the juice is very difficult In practice it often happens that the flow of juice is irregular and the sugar is incompletely extracted

Hence many inventors have attempted to devise automatic and continuously acting apparatus The problem now appears to have been solved after many fruitless efforts In Austria within the last two years several factories have adopted a continuous diffusion process invented by Von Hyross and Rak which has given complete satisfaction The Hyross Rak apparatus (Fig 1) comprises four tall conical diffusion vessels assembled with their small ends alternately below and above and with the small end of the first three vessels communicating with the large end of the next vessel The vessels are also connected by pipes which run from the middle of the fourth vessel to the top of the third from the middle of the third to the bottom of the second and from the middle of the second to the top of the first The beets are forced downward through the first and third vessels and upward through the second and fourth vessels by screw blades geared to shafts above and below the apparatus The fresh beets are conveyed by a chain pump from the cutting machine to a hopper above the first vessel *D* and the exhausted beets are discharged from the top of the fourth vessel *H* Water enters at the bottom of the fourth vessel flows by means of the small pipes through the other vessels continually taking up sugar from the beets which it encounters and is discharged as a strong syrup or juice from the lower part of the first vessel *D* In the uppermost section *I* of the first vessel, the fresh beets are thoroughly mixed with the juice already rich in sugar which flows in through the small pipe from the second vessel In the succeeding and longer section *II* diffusion takes place until the liquid inside and outside the cells of the beets is of equal concentration In the next section *III* the juice is pressed out of the beets by the contraction of the walls of the vessel and the enlargement of the shaft of the screw and flows through perforations in the inner wall to the outlet pipe which delivers it to the refining and evaporating apparatus From section *III* the beets still compressed to prevent reabsorption of liquid are forced by the screw into the wide horizontal passage *IV* Here they are mixed by vertical paddles at the bottom of the screw with juice which flows in at *G* from the third vessel and which is weaker than the juice which they have already encountered The mixture passes into the second diffusion vessel which is similar to the first except that it is inverted and in which the same operations are repeated the juice flowing into the upper section of the first vessel and the compressed beets passing into the mixing chamber *R* of the third vessel where they are stirred with the weak juice which flows in from the fourth vessel In this way the beets and the liquid pass in opposite directions through the four (or six) vessels which constitute the diffusion battery The temperature of the juice is maintained and regulated by steam coils in the mixing chambers

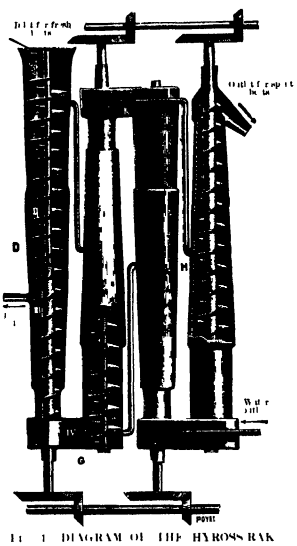

FIG 1 DIAGRAM OF THE HYROSS RAK CONTINUOUS DIFFUSION PROCESS

All continuous industrial processes possess the advantages of increased and more regular production diminution in the number of workmen and comparative independence of their attentiveness and good will but the Hyross Rak presents still other points of superiority over the discontinuous diffusion processes commonly employed There is no waste water resulting from the pressing of the beets and the washing of the diffusion vessels Hence there is a saving both in water and in waste products which must be purified at considerable expense before they can be thrown into streams The water employed for diffusion is the ammoniacal water which is obtained by condensing the vapors of the evaporating pans The juice is richer than the product of the discontinuous process and the spent beets form a more nutritious fodder as they contain 20 per cent instead of 10 per cent of dry matter The apparatus occupies much less space than is required for the ordinary process, as is shown by Figs 2 and 3 Finally, the diminution of the quantity of water which must be pumped, heated and evaporated results in a saving of fuel which may exceed $1 000 annually for an establishment of average size —La Nature

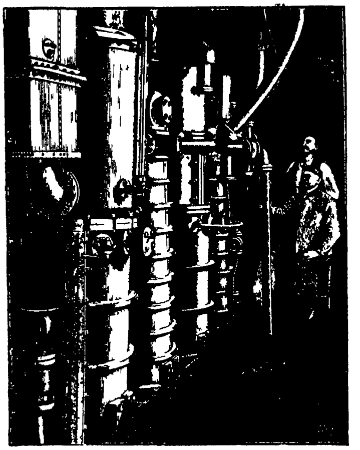

FIG 2—HYROSS RAK CONTINUOUS DIFFUSION BATTERY

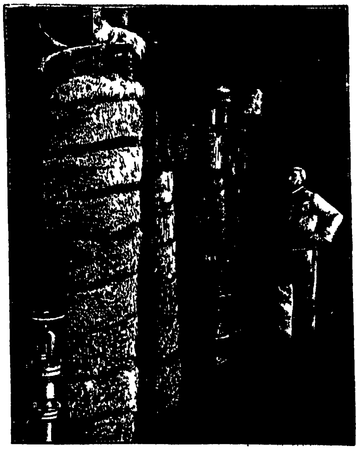

FIG 3—THE BATTERY WITH THE WALLS OF THE DIFFUSION VESSELS REMOVED SHOWING THE BEET PULP IN SPIRAL LAYERS SEPARATED BY THE SCREW BLADES

KEEL WATER AND ITS CAUSE.

A PHYSICAL EXPLANATION.

BY NAVAL CONSTRUCTOR ULFFERS.

PROF. OSTWALD, in a recent article, describes that often observed, but little understood, phenomenon which is commonly called keel water In connection therewith, Ostwald describes the phenomena of surface tension and the effect of thin layers of oil upon the surface tension of water In these phenomena he finds the explanation of the effect of oil in stilling the waves, which has frequently been observed, and in recent years has been utilized in life saving operations in heavy seas But this modification of the surface tension does not suffice to explain the origin of keel water, the essential cause of which is to be sought in a very different field If the oil which is expelled by a steamer were the sole cause of the smooth track which the vessel leaves behind it, the width of this track would not agree so exactly as it does with the width of the hull In consequence of the great extensibility possessed by layers of oil floating upon water, the track would vary in width according to the quantity of oil exuded rather than in proportion to the width of the vessel Undoubtedly the steam which escapes from a piston engine lubricated with oil sometimes carries considerable quantities of oil with it, but this oil does not, as a rule, become mixed with the condenser water or escape from the ship, for modern marine engines use surface condensers, in which the exhaust steam surrounds a system of pipes which are cooled by an internal circulation of sea water Consequently, the steam and the condenser water do not come into contact except in case of leakage The quantity of oil which escapes by reason of such leakage is too small and too uncertain to produce the well marked and regular phenomena of keel water Furthermore, oil is not used in the lubrication of steam turbines, yet turbine steamers produce keel water in an especially high degree Finally, careful observation has demonstrated that sailing vessels are not, as was formerly supposed, entirely free from keel water. The writer has often observed a very distinct and regular formation of keel water by very small yachts The fact is that every body which is drawn along the surface of the water leaves behind it a smooth track which is wider, more conspicuous, and more permanent in proportion to the size of the body and its velocity In order to explain the formation of this track, or keel water, we must study the phenomena of the resistance opposed by water to the motion of a solid body If a teaspoon is half immersed in a cup of coffee, and drawn through it with its convexity in front, it is easy to observe that the liquid flows to both sides of the spoon, and that two funnel-shaped eddies are formed at the edges of the spoon It can also be observed that a certain interval of time is required for the formation of these eddies, and that they persist long after the cause which produced them has ceased to act This simple and instructive experiment has been developed in scientific form by Prof Ahlborn, two of whose interesting experiments are here described and pictured. Fig 1 shows the eddies and disturbance in the water produced by the movement of a flat plate with its plane normal to the surface, and Fig. 2 shows the corresponding effects produced by an oval or more ship-shaped body

These eddies furnish the basis of the explanation of keel water Every rotating body tends to preserve its axis and plane of rotation unchanged This is observed in the common top and in gyroscopic apparatus of all kinds, also in the child's hoop and the bicycle. The gyroscopic action of swiftly rotating masses is frequently utilised in maintaining a direction of motion unchanged, as, for example, in the launching of torpedoes, and, quite recently, in diminishing the rolling of vessels (Schlick's marine gyrostat) Similarly, a gyrostatic compass, the axis of which remains permanently parallel to that of the earth, has been recommended and to some extent employed as a substitute for the magnetic compass The eddies produced by the motion of a body through water possess the same gyrostatic properties, and consequently tend to maintain their axes of rotation vertical of their planes of rotation horizontal. Consequently, they have a smoothing effect upon the surface of the water, and successfully resist the disturbing action of the influences which ordinarily give rise to the smallest waves and ripples. The large waves are not affected by these eddies, which are simply carried up and down upon their surfaces. The result is the formation of the smooth track, destitute of small waves, which has an oily appearance and is known as the keel water But in destroying the small waves the eddies are finally themselves destroyed, and the surface resumes its normal appearance The effect of the eddies lasts for a time which depends upon the size and velocity of the vessel which produces them For this reason, the keel water is commonly observed only in the case of steamers, which, as a rule, are both larger and swifter than sailing vessels Furthermore the commotion produced in the water by the paddle wheels and screws increases the formation of eddies and the general agitation of the water By careful attention it may be observed that all eddies which are formed at any part of the ship's side or are caused by the paddle wheel or screw come together in the keel water, and trail in a long series in the smooth wake behind the ship which is sharply distinguished from the rough water on either side—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Kosmos

FIG 1—EDDIES PRODUCED BY A FLAT PLATE

FIG 2.—EDDIES PRODUCED BY AN ELLIPTICAL PRISM.

THE REFRACTIVITY OF RADIUM EMANATION

SEVERAL English physicists have been endeavoring to determine the refractive index of radium emanation, not only for the intrinsic interest of a knowledge of the refractivity in question, but also because of the great probability of the emanation's being one of the series of non valent elements Lord Rayleigh, Alfred W Porter, and Clive Cuthbertson have been working in this field All of them have given accounts of their work in Nature

Because of the minute quantity of emanation available, the refractometer employed must necessarily be minute Messrs Porter and Cuthbertson use a tiny interferometer vessel, 2 251 millimeters long and 0 71 millimeter in diameter in which they compress the emanation through the capillary tube by means of a mercury column Set up in the path of the green beam separate spectroscopically from the light given by a Bastian mercury lamp the light passing through was examined through an astronomical eyepiece, with the result that interference bands were obtained so clear that they could be measured micrometrically to the hundredth part of a band The method of a determination, in general outline, consisted in alternately increasing and decreasing the pressure of the contained gas from and back to a practically zero value and observing the number of interference bands which passed over the cross wire of the micrometer. In order to determine the efficiency of the arrangement, observations were made for the refractivity of air, with the result that an accuracy to within about 2 per cent could be relied upon, so far as the optical part of the experiments is concerned.

The real difficulties begin, however, with the emanation itself The rapid generation of impurities, originating in part in the action of the emanation upon the resinous cement employed for fixing the parallel plates, together with the lack of a knowledge of what these impurities are, made it impossible to calculate the index of the emanation from the experimental results, although it was perfectly easy to measure the refractivity of the mixture of gases existing at any time The only datum known in regard to the composition of the mixture was the approximate percentage of emanation present, this being found by measuring the γ radiation from it The direction in which the refractivity lies may, however, be inferred with probability from the following observations Starting with emanation given off from a solution and containing a very large amount of impurity this was purified, first, by explosion, drying, and absorption of CO, and afterward by freezing in liquid air and pumping off the volatile impurities according to well known methods Testing the refractivity from time to time its value—at first of the order of that of air—did not sensibly rise until the volume was about one cubic millimeter Continued purification increased the refractivity, and the highest values obtained in the experiments were 0 000840 when the volume was 0 205 cubic millimeter (at atmospheric pressure) and 0 000916 when the volume was 0 128 cubic millimeter at atmospheric pressure The quantity of emanation was approximately the same for both these measurements, and equaled the quantity in equilibrium with 0 178 gramme of radium Of course, if it could be assumed that the impurities were the same in kind on the two occasions it would be possible to estimate from these data the value for the pure substance, but the failure of this method on many occasions to give consistent results took away all belief in its applicability For purposes of comparison the higher of the above values is about twenty six times the value of helium, while the value for xenon—the highest for any known gaseous element—is twenty times and for CO thirteen times the value of helium

One source of difficulty so long as the available amount of emanation is so small is that the maximum pressure to which it can be raised in the apparatus is only a few (7 or 8) centimeters The capillary correction thus becomes exceedingly important, and Sir W Ramsay has given reasons for believing that the capillary behavior of mercury is quite abnormal in the presence of emanation Another serious difficulty was that, under the action of the emanation, the silver (or platinum) through which the light had to pass gradually became opaque The consequence was that the apparatus had each time to be dismounted after a couple of days, the faces re polished, re silvered, and re installed before a new experiment could be begun This source of inconvenience would, of course, not be present in apparatus similar to the Young Arago method employed by Lord Rayleigh or in a Jamin refractometer (which is the more satisfactory of the two), but we do not think that it would be possible to obtain an equal optical efficiency with these arrangements

The amount of success attending these experiments—small though it may seem to be—leads to the hope that if the amount of available emanation were increased a few times only, an approximate value of the refractivity would be ascertainable Even at the present time this might be effected by means of a collaboration among all those who possess large quantities of radium

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National forestry operations in Italy have been carried on for forty years, and a report just issued by the Secretary of Agriculture of that country shows that the government are conducting a vigorous policy of afforestation in order to remedy the ruinous conditions which followed the destruction of trees in the past During the last thirty years 122 000 acres of government land have been planted in twenty five provinces, of which area 69 000 acres were planted in 1907 and this work is being carried on so rapidly that only about 36,000 acres of government land now needs planting The government have also distributed great numbers of young trees and seeds for planting private property Work of such an expensive nature in a country where the demands for national funds are so numerous and pressing as in Italy is a significant commentary on the value set upon afforestation where the experience of many centuries furnishes considerable information of unquestioned value regarding matters of this nature

THE CUSTOM OF WAR

ANCIENT AND MODERN CODES.

By the custom of war is meant that code of laws and usages, mostly unwritten, which regulates the conduct of belligerents toward each other. It is little more than a century since this custom of war permitted the general of a besieging army to encourage his men with the promise that when the place fell they would be allowed to sack it for a day and plunder freely. Such a right is never now exercised against civilized enemies, but the old practice has, it is to be feared, been more than once connived at, to say the very least, in the case of uncivilized foes. To go back a little farther, one finds honorable soldiers summoning a castle or fortress to surrender, and warning the garrison that as the place was considered to be untenable they would give no quarter if they were forced to storm it. We have a reference to this custom in one of Major Dugald Dalgetty's stories of the glorious wars of Gustavus Adolphus, when he tells Monteith:

"I was in a brigade of Irish at the taking of Frankfort upon the Oder, stand to it with sword and pike until they beat off the blue and yellow Swedish brigades, esteemed as stout as any that fought under the immortal Gustavus. And although stout Hepburn, valiant Lumsdale, and Monroe, with myself and other cavaliers, made entry elsewhere at point of pike, [illegible] all met with such opposition we had returned with great loss and little profit. Wherefore the valiant Irish, being all put to the sword, as is usual in such cases, did nevertheless gain immortal praise and honor."

Scott here makes the major speak the language of his time. The refusal of quarter was defended on the ground that men who held out when there was no chance of victory were inflicting useless loss on their opponents, and thus deserved to lose their own lives. But nowadays the threat to massacre the heroes of a desperate defense would be regarded as infamous. War in this respect has become more chivalrous. And the whole progressive evolution of the custom has been in the direction of humanizing war. In the Middle Ages quarter was given to knights and nobles, for they could be held to profitable ransom, but mere common soldiers were cut down, for there was no profit in making them prisoners. Strangely enough this was the indirect result of a great forward step in the progress of civilization. Soldiers of still earlier times, when slavery was a worldwide institution, were anxious to take hundreds of prisoners, for they could be sold and were worth money. The abolition of slavery led at first to more slaughter in the rout of a beaten army.

War at the best is a horrible business. Only those who have never seen it have any other opinion. But though the actual means of destruction have grown more deadly, war has become in a great degree humanized, and is not so horrible as it was. The tendency now is to avoid useless killing and mere destruction for its own sake, and quarter is always freely given. Men who have ceased to resist actively are only sometimes killed when blood is hot, as when a position is stormed with the bayonet or in the first rush of victorious cavalry. But there is no slaughter in cold blood, and there is not any idea of the deliberate killing of noncombatants, though if they are within the range of fire they must of course take their chance. The wounded are cared for to whichever side they belong. Plunder and outrage are sternly repressed.

It is easy enough for a logical-minded critic to point out the contradiction of first using the resources of science to disable a man, and then taking even greater trouble to restore him to health. The contradiction is apparent only, not real. The object of the soldier who is no longer a bloodthirsty barbarian but a civilized Christian is primarily not to kill his enemies, but to break their power of resistance and put them *hors de combat*, or (to use a phrase taken from peace maneuvers) put them out of action. This is no mere ideal distinction, but happily represents a [illegible] the outcome of centuries of progress. The Red Indian killed outright and took the scalps of his enemies. More than one Eastern fighting race collected the heads of as many slain foes as possible. The European soldier kills, but the killing is not massacre; it is the result of using deadly weapons to knock out and terrify his opponents. A general does not exult in the number of the dead on the other side. What he aims at is to have crowds of wounded and unwounded prisoners, with as many thousands more of the enemy as possible dispersed, disorganized, cut off from their supplies, and no longer dangerous. Hence killing for the mere sake of killing is avoided.

Even in the heat of battle this is so. After one of our victories in the Sudan an officer telling me of his personal experiences said: "I rode in among the Dervishes. They had no fight in them, and were bolting like rabbits. I could easily have shot half a dozen with my pistol, but it's not my business to kill men running, but to lead my battalion." Another officer who now wears the V.C. told how in a cavalry fight the opposing troops met in a cloud of dust, and as it cleared he saw a Dervish horseman cut off from his friends riding beside him. "I could have killed him," he said, "but he looked such a sportsman that I let him go." Outposts remain in sight of each other for days without exchanging a shot. Disciplined troops soon realize that killing stray men is of no particular advantage, and firing on the outpost line means disturbance of the rest of the camp or bivouac behind it. It is only uncivilized hillmen of the Indian northwest frontier who keep everyone awake by sniping or sending long-range shots at random into a camp.

Nothing is more unlike the stay-at-home civilian's idea of war than the conduct of opposing outpost lines. Gen. Sir Richard Harrison in his recently published "Recollections" describes a visit he made to the outposts of the Federal army during the American civil war. The Confederate picket line was well within rifle range, and he was able, after an exchange of friendly signals, to ride across and have a talk with the Southerners. "A hill only was between the combatants," he says, "but they had been fighting too long and too seriously to keep up an incessant conflict between outposts. In fact they had arrived at the condition experienced by our troops and the French at the end of the Peninsular war. Sentries and vedettes signaled when an advance was imminent from either side, and unless special orders had been received to the contrary, the outposts retired before the signal without an attempt to shed blood."

Gen. Harrison's reference to the Peninsula reminds us that the records of that war are full of instances of the friendly courtesy of the opposing forces. Men on hostile outpost lines would slip across to ask for a light or buy tobacco from each other. A British officer inspecting the outposts saw an advanced French sentry asleep. Instead of carrying him off a prisoner, he rode over and woke him up, and told him he did not want to see a young fellow get into trouble by being found asleep at his post. In a lull of the fighting at Talavera French and English soldiers came down to the same stream and drank together.

In the lines outside Metz and Paris during the Franco-German war there was the same tendency for the tacit truce on the outpost line to lead to irregular fraternization between the opposing forces, but on account of the fear of its being taken advantage of for purposes of espionage, strong measures were adopted to keep Frenchmen and Germans from smoking, drinking, and playing cards together.

When it comes to actual fighting the custom of war forbids certain effective methods of getting rid of an enemy. One may cut off his water supply, and thus inflict serious suffering on all concerned, and if the deprivation is prolonged produce an outbreak of pestilence, but one must not poison wells, reservoirs or streams. The rebels in Arabia practised this method against the Turks, and in the war between Japan and China the Japanese in their advance through Corea did not use the village wells, but substituted for them Abyssinian tube wells and other methods of obtaining a reliable supply, because they had been warned that the Chinese might poison the wells—conduct which civilized belligerents regard as utter savagery. The underlying principle of the unwritten code that allows one to cut off the water supply and forbids one to poison it appears to be that a belligerent may take steps that will indirectly cause sickness among the enemy, but must not work directly and intentionally for this end. In earlier centuries the distinction was not made so delicately. A mediæval writer on artillery describes how to produce pestilence in a besieged town. His method is to allow the dead bodies of horses and cattle to become corrupt, and then cut them into convenient pieces and shoot them into the town with catapults. One wonders if this plan was ever adopted.

The custom of war, which in this case is to some extent set forth in international conventions, also forbids mere useless maiming and the infliction of avoidable suffering. Thus the use of the explosive rifle bullet is forbidden. In other words, one may inflict a bullet wound that will disable a man, perhaps kill him, but one must not do it in such a way as inevitably to inflict horrible and deadly wounds. On this principle there has followed a tacit understanding among civilized nations not to use soft-nosed, collapsible bullets that set up or mushroom, the kind of bullets now used against big game. This was why during our South African war army orders forbade the use of the dum-dum rifle bullet and of a type of enlarging pistol bullet. But there is a tendency to use these ugly bullets against savage foes. The reason for making this difference is that while the more or less educated civilized soldier, when he is hit even by a small bullet and the injury is slight, will mostly become nervously anxious to have it attended to at once, while the uneducated barbarian who has no nerves to worry him, and as Mr. Kipling puts it "knows no more of his inside arrangements than an eight-day clock does of its works," is very likely to come on and get to close quarters even after two or three small bullets have gone through him. This is why the soldier who is handier with the rifle than the bayonet likes to have a "man-stopping" bullet.

Explosive bullets being forbidden, a lower limit has to be set to the size of projectiles that carry a bursting charge. No shell must weigh less than half a kilogramme, that is roughly a pound. Hence the smallest shell used is the little one-inch steel shell for the "pom-pom," fired in sets of ten that burst like a string of crackers. In South Africa they inflicted few casualties, but they got strangely on men's nerves. Rifle and heavy artillery fire was easier to face than these nasty little projectiles.

One wishes the prohibition against small exploding projectiles could be extended to the grenades filled with high explosives that were introduced by the Japanese in their war with Russia. They were used in storming entrenchments, and were fired from wooden mortars which two men could run up with to the firing point. They produced hideous injuries, blowing away limbs, faces, one side of the body, crippling for life those they did not kill outright. It may not be generally known that our army has practically adopted the idea, and experiments have been made at Woolwich with high-explosive grenades and portable mortars. It seems a repulsively cruel method of fighting, though it must be said that ordinary heavy shell fire also inflicts very nasty injuries.

In one respect war has become notably less chivalrous. In the Middle Ages up to a comparatively late date there was a disposition to regard battle as a tournament on a large scale. There was an idea that armies should be matched on equal terms on a "fair field." When James IV of Scotland marched across the Border in 1513, and on the approach of Lord Surrey's English army took up a position to await battle on Flodden Hill, steep on both flanks and defended in front by the deep river Till, Surrey sent him a letter complaining that he had put himself into ground more like a fortress or a camp than any indifferent (that is, equal and fair) ground for battle to be tried. A modern general receiving such a letter would think his opponent had lost his wits. By interposing between the Scottish camp and Scotland Surrey succeeded in luring King James into leaving his vantage ground and attacking with disastrous results. Nowadays everything is fair in war except assassination and treachery.

Spies are hanged or shot if they are detected, not because espionage is a crime in itself, but to make the spy's business more difficult and deter people from taking it up. The essence of espionage is disguise. An officer, if he is in uniform, may venture as far as he likes to go to reconnoiter an enemy. He is not a spy unless he disguises himself. The Japanese in the last war showed themselves past masters in espionage, but they used methods that Western nations would consider unjustifiable. They employed natives of Corea and Manchuria to act as spies in the Russian lines, and if report speaks truly these agents ran a double risk. If the Russians detected them they were hanged; if they came back without satisfactory information they might be shot by their employers "to encourage the others." Our Eastern allies still keep to a very grim kind of custom of war. Rumor says that at the naval battle of Tsushima hopelessly wounded men were quietly dropped overboard to clear the decks and save unnecessary trouble.

Connected with the custom as to spies are the written or unwritten laws that forbid the people of the country from taking an active part in its defense unless they have at least some plain badge to show they are combatants. The whole legislation as to the patriotic action of civilians is a little confused. The German military law orders that in case of invasion the levy *en masse* or Landsturm is to be called out, and the armed inhabitants who thus come into action need not have uniforms, yet the Prussians used to shoot captured *francs-tireurs* in France on the ground that they were irregular combatants without recognized uniform or commissioned officers. It is generally recognized that the people of a town may fight in its defense without uniforms, for in a siege all the people within the fortifications are presumably enemies of the besieger.

The Hague Convention recognizes the right of the civilians of an invaded district not yet effectively subdued by the invader to fight in its defense even if they are not uniformed. Thus the execution of Mr. Brown for defending his home in the play known as "An Englishman's Home" is an episode based on ignorance of current military usage, though the author of the play is a soldier.

The use and abuse of the white flag of truce is again a subject of much discussion. There probably has been no war in recent years in which each side did not charge the other with treacherous misuse of this flag. Sometimes the origin of such charges is clearly that, as in the case of our own men in the surrender at Nicholson's Nek—while some are ready to surrender and show the white flag, others are anxious to fight on and continue firing. It may not be generally known that the recognized custom of war allows troops in certain cases to fire on the bearer of a white flag. To display the flag means that one wants to communicate. If the other side is willing to do so, they cease firing, stop their advance, and signal to the white flag bearer to come forward. But they are also free to refuse to communicate. In this case they may signal a refusal and continue advancing and firing. If the bearer of the white flag persists in coming on he may be shot down. The reason for this is that if the mere display of a white flag necessarily stopped the fighting, it might be used at a critical moment to delay temporarily the advance of the attack on an important point. But the right of refusing to let the white flag come forward is very rarely used.

The most satisfactory development of the custom of war is the legislation as to the Red Cross embodied in the Geneva Conventions. Its effect is to neutralize and give as much security as possible to all that is connected with the care of the sick and wounded. The change does not affect only the actual battlefield. In the American civil war the Federals treated quinine as contraband when the Confederate hospitals were sore stricken for the want of it. Now the cases marked with the Red Cross would be passed through the outpost lines. The Red Cross flag, the most honored standard displayed in war, is really the flag of Switzerland with the colors reversed. The Swiss flag is a white cross on a red ground; the ambulance flag makes the ground white and the cross red; and Switzerland has the further honor that the legislation for the care of the wounded was drawn up in a Swiss city. Thus it was not without reason that a Swiss orator once said: "Our flag does not fly as the standard of conquering and devastating armies, but it is a flag of ours that is carried into the midst of the misery and ruin of war all the world over, and has already been displayed on a hundred battlefields as the symbol not of war and death, but of life, mercy, and charity."—Chambers's Journal.

Chinese wood oil, which is fast becoming one of the staple market products of central China, and of which considerable quantities are shipped from Hankow, is obtained by cold pressure from the nuts of the tung tree, which grows extensively in the Yangtse Valley. Recently it has been used to some extent in the manufacture of varnishes of various descriptions. Its peculiar property of drying flat with a surface very similar to that shown by ground glass has up to the present time prevented its use to any great extent in the manufacture of paint. Alone or with pigments it dries with a dead appearance, and even when used in a small proportion with other oils and varnish it tends to cause a "flatting" and sometimes crinkling surface to whatever it may be applied. The former property has been utilized to produce varnishes in which wax was formerly used as an ingredient. China wood oil has other peculiarities which render it vastly different from all other drying oils. The odor is very characteristic and stubbornly resists destruction, regardless of the manner in which the oil is treated. This admits of its identification when present in but small proportions in varnishes, etc., regardless of other constituents. Another very interesting property is the instant change into a jelly-like substance when heated to [illegible]00 deg. C. The material this produces is insoluble in all ordinary solvents and cannot be melted by further heating. The properties of this oil which have brought it into extensive use are several. The oil may be heated without discoloration. It can be treated so as to remove the tendency to "flat," and then produces varnishes with a fine gloss. It has the property of drying hard but tough, and when used with rosin will produce better results than when mixed with linseed oil. Its use has made it possible to produce a number of good varnishes at a very low cost. The best grade of China wood oil is thicker than linseed oil, with the specific gravity of 0.994 at 15 deg. C. and flashing point at 280 deg. C. When applied to a flat surface the drying appears to take place throughout the entire body of the oil at one time, instead of from the top down, as is the case with many other oils. When heated to about 260 deg. C. with pure manganese borate the oil, if pure, is not discolored.—Daily Consular and Trade Reports.

FILTERS FOR ULTRA-MICROSCOPICAL PARTICLES.

Different processes are used for purifying alimentary and industrial liquids. The most effective and economical of these at first sight would seem to be sterilization by heating. Recent researches have, however, shown that, apart from the evident loss of flavor, both the digestive and nutritive properties of liquids thus treated are greatly impaired. Furthermore, filtration cannot be dispensed with even after sterilization, simply to get rid of foreign matter causing turbidity.

Efficient filtration would doubtless be more advantageous. However, filtration devices designed on the principle of the Chamberland candle, which are at present in use, are defective in many respects. In fact, the filters keep back the minute particles by molecular adhesion on the filter walls rather than by the narrowness of their filter channels, so that the microbes contained in the liquid after some time (in some cases after from three to four hours) begin to pass through, either by virtue of their multiplication in the interior of the filtering channels or by virtue of their lively motion, which eventually carries them beyond the range of capillary attraction. Furthermore, these filtering candles allow viscous liquids to pass only slowly.

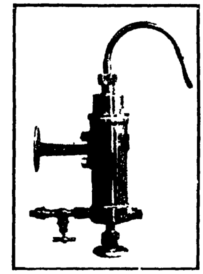


FIG. 1.—THE DOMESTIC APPARATUS.

Dr. Bechhold of Frankfort-on-the-Main some time ago suggested a new principle of filter construction, which consists in passing the liquid through a gelatine layer. More recently two French engineers, Messrs. [illegible] Gobbi and [illegible] H. Faint, have carried out successfully another system of construction, recorded in a communication to the French Academy.

The two inventors have endeavored primarily to solve the problem of avoiding any rapid obstruction of the filter, while making the filtering process both cheaper and safer.

They discarded all porous substances, either of mineral or vegetable origin, using only unalterable, resisting, and comparatively cheap materials. The apparatus was finally to be so designed as to be always got into working condition merely by washing, without being unmounted, and to lend itself to the filtering of the most widely different liquids.

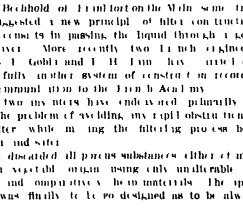


FIG. 2.—SECTIONAL VIEW OF THE GOBBI-FAINT ULTRAMICROSCOPIC FILTER.

The filters submitted to the Academy are mainly based on the narrowness of the channels, the microbes being definitely and not temporarily arrested by the extreme smallness of the interstices. Capillary attraction is reduced by making the filtering interstices shorter and more regular, so as to allow of the integral passage of toxines, diastases, and other viscous liquids. These filters thus arrest during some hours, even for the space of a day, the colloidal grains of dyeing substances, and are maintained indefinitely sterile.

The filters consist of a nickel tape 1/10 millimeter in thickness and [illegible] millimeters in width (length of the filter patch). This tape, some hundreds of meters in length, is wound helicoidally on its broad side, the various spirals being forced against one another by means of a screw, so as to constitute a compact cylinder.

This cylinder could be rendered impervious by tightening the screw, but for a series of minute transverse ridges projecting from one of the faces of the tape at very short distances from one another. In this manner are obtained very regular interstices of the dimensions most convenient for the industrial or scientific application at issue. The protuberances, and accordingly the interstices, can for instance be reduced to dimensions smaller than those of the most minute microbes, while the width of the tape can also be reduced with a view to diminishing the friction of the liquid.

The remarkable smallness of the interstices of this filter (which by the way could be made of even smaller dimensions) allows not only the microbes held back by ordinary filters, but even the grains of colloids, which are far smaller than the former, to be arrested, and justifies the name of "ultra-microscopical filter."

* * *

RECLAIMING MESOPOTAMIA.

An important report has been presented to the Turkish government by Sir William Willcocks, the eminent English irrigation engineer, respecting the ways and means of reclaiming the territory of Mesopotamia and restoring this country to its former prosperity. Some months ago, upon the reconstruction of the Ottoman Constitution, Sir William Willcocks was requested by the Turkish authorities to proceed from Egypt, in the irrigation schemes of which country he has carried out a prominent part, to the country of the Tigris and Euphrates, to elaborate a scheme for restoring the irrigation system which formerly existed centuries ago and which had fallen into desuetude.

As a result of his investigations in the Delta of these two rivers, the engineer has suggested irrigation works to the value of about $[illegible]00,000, divided approximately equally between the two waterways. He advocates the erection of barrages on the Hindieh Canal and on the Habbania and Sakhlawia, as well as improving the navigation of the Tigris. As a result of these works it would be possible to restore 247,410,000 acres out of the total area of [illegible]0,000 acres comprising the Tigris-Euphrates Delta to their former prosperity, and the works would occupy about eight years to complete.

In addition to these irrigation works the engineer strongly advocates railroad communication between the Delta and the Mediterranean, to facilitate transportation between the two points and to provide a convenient channel to Europe for the produce of the country. He suggests a railroad of [illegible] feet gage from Bagdad to Damascus, effecting a junction with the Hedjaz railway and reaching the sea at Haifa, the present tidewater terminal of the sacred railway to Mecca. Such a line would be about [illegible]00 miles in length, and its cost would average about $1[illegible]00 per mile, while it could be completed in about two years. Such a line, he points out, would be the main artery of traffic in all produce raised in the most eastern Turkish territory in Asia, and also of Persia, while in the opposite direction would be conveyed the bulk of the import traffic. He also points out that it would afford easy access for American and European tourists and travelers to the ancient districts of Baalbec, the Garden of Eden, Chaldea, Babylon, etc., which at present are so difficult to reach. This traffic alone, he maintains, would be considerable. In addition, by forming a junction with the Holy railway at Damascus, there would be a considerable Mahommedan traffic in connection with the pilgrimage of the East Asian Mahommedans to the sacred cities of Islam. He opines that such a railway would give an annual profit of $1[illegible]6,000 per annum before the proposed irrigation works were completed, which revenue would be very appreciably augmented as the Tigris-Euphrates Delta was reclaimed.

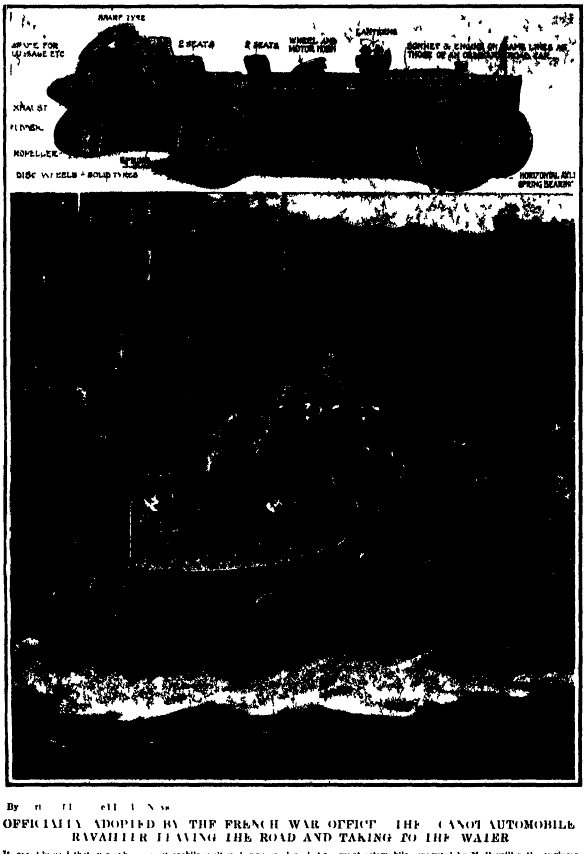
These important schemes are being carefully considered by the Ottoman government, and Sir William Willcocks was recently in England in connection with construction and materials for the irrigation works, which are to be undertaken at once. An English syndicate has already offered, in conjunction with Turkish capital, to construct the railway, upon which, however, no definite official decision has yet been pronounced, though it is anticipated that the works will be carried out in the near future. The navigation of the Tigris, which is at present an English monopoly, has recently been strengthened by the introduction of Ottoman interests, and it is expected that there will ensue a wave of revived prosperity in the lands so famous in Biblical history. Certainly this territory is the most fruitful in the whole of the Ottoman Empire, if its reclamation is carried out upon such broad, comprehensive lines as are advocated by the well-known English engineer, who has since arrived in Constantinople in connection therewith.

A NEW AUTOMOBILE BOAT.

AN AMPHIBIOUS CRAFT.

BY WALTER ROGERS.

A French inventor, J. Ravailler, has devised a self-propelling vehicle which can navigate the water like an ordinary motor boat and also travel overland like an automobile. The official tests of the boat recently made in the presence of M. Barthou, the Minister of Public Works, and other distinguished persons were crowned with complete success. To tourists who make use of this amphibious vehicle, canals, rivers, and lakes will present no serious difficulties, as they can be crossed with ease and comfort wherever moderately gentle and smooth slopes, natural or artificial, can be found for entering and leaving the water.


SPARE TYRE
SPACE FOR LUGGAGE ETC
2 SEATS
2 SEATS
WHEEL AND MOTOR HIGH
LANTERNS
BONNET & ENGINE ON SAME LINES AS THOSE OF AN ORDINARY ROAD CAR
EXHAUST
RUDDER
PROPELLER
SPRING
DISC WHEELS + SOLID TYRES
HORIZONTAL AXLE SPRING BEARING

By [illegible]

OFFICIALLY ADOPTED BY THE FRENCH WAR OFFICE: THE "CANOT AUTOMOBILE RAVAILLER" LEAVING THE ROAD AND TAKING TO THE WATER.

It [illegible] automobile [illegible] canot automobile, invented by M. Ravailler, the engineer, is the first [illegible] officially adopted by [illegible] for military or other purposes. It is believed that the machine, [illegible] first [illegible] at Versailles by the French War Office, will be of great value in scouting, [illegible] taking [illegible] across a stream [illegible] bridge [illegible] like that made [illegible] can surmount gradients of 15 per cent [illegible] about 9 kilometers an hour. The transmission of the driving power from the wheels to the propeller [illegible] is as simple [illegible].

The hull of the boat, which is made of steel plates riveted to steel ribs of T-shaped section, is mounted by means of springs on axles and wheels of pressed steel. The axles pass through water-tight tubes which traverse the hull. This part of the construction, which is very cleverly designed, is the invention of M. Gustave Pitre, the naval architect of the Maisons Laffitte.

The motor (constructed by Gontallier of Vincennes) is placed near the bow. It drives, by means of a clutch of the disk type, two distinct systems of mechanism. 1. A variable speed shaft transmits the power to the rear or driving wheels by means of chains and pinions, the arbors of which pass through stuffing boxes. Three forward speeds and one backward speed are provided. Coupling, retarding and speed changing levers, a differential brake worked by a pedal, and a brake lever acting on the rear wheels complete the mechanism of propulsion on land. Steering is effected, as in an ordinary automobile, by a wheel passing through a stuffing box. 2. The variable speed driving shaft prolonged backward beyond the rear axle may be connected by means of a clutch with a screw propeller at the stern of the boat, the connection being made by moving a lever placed at the left hand of the driver of the vehicle. The rudder and the front axle are turned by the same steering wheel.

The capstan, which is seen at the bow of the boat, is turned by a tangent screw which is driven by the motor by means of a wheel and belt, and connected and disconnected by a loose wheel or idler.

The driving wheels, the propeller, and the capstan can be operated separately or simultaneously.

The speed of the vehicle, as determined by numerous trials, is 35 kilometers (21¾ miles) per hour on land and 9 kilometers (5.6 miles) per hour in the water.

The boat enters and leaves the water without any preparation or change except in mechanical connections. When afloat its stability is perfect, as is shown by one of the illustrations. It leaves the water and climbs the bank under the impulsion of its driving wheels if the ground is reasonably firm and the grade less than 15 per cent. If the bank is steeper or softer a rope is fastened to a stake driven into the ground and the boat is hauled up by the capstan.

The equipment of the boat is completed by a pump for bailing, an anchor, a buoy, and a pair of oars and movable rowlocks for use in case of accident to the motor while afloat.

The Ravailler automobile boat seems destined to render valuable services to tourists. The best proof of the practical value of this invention is the fact that it has been purchased, together with all its patents, by an American.

A BINOCULAR FALLACY

We have been struck of late by the persistence with which the old myth with regard to the combination of colors by binocular vision holds its ground. Long ago it was demolished by Du Tour and by Wheatstone, but it is now revived, and actually made to serve as the basis of methods of producing stereoscopic photographs in natural colors. The ignorance which prevails on the subject is evidenced by the fact that in one projected process the colors are assumed to combine additively, while in another they have to combine on subtractive principles. Both cannot be right, while it is quite clear to anyone who has experimented with the binocular combination of colors that actually both are wrong. The result is not a mixture of the two colors, but confusion. If, for example, one image is red and the other blue in a stereoscopic slide, we may intermittently see a violet image, but in between whiles we shall see alternating blue and red images. If, as an alternative experiment, we view a white object through blue and red glasses, we get very similarly changing effects, with the difference that the colors are so feeble as to look almost like neutral tints. One explanation of these variable phenomena is that the eyes always see alternately. This was advanced by Du Tour and a few others, but it is hardly a proved fact. Another suggestion is that the changes are due to non-coincident after-images, but this again is hardly feasible. Possibly the simplest and truest explanation is that our eyes are not constructed for the purpose of combining colors in this fashion. We know that if red and blue together strike one retinal unit in the eye we get the sensation of violet, but there is no warrant for assuming that when red meets one retinal unit in the eye, and blue a corresponding unit in the other, we shall again get a sensation of violet.

Theory has not a scrap of evidence to suggest that we should do so, while practice proves that we only do so occasionally and by a kind of a fluke. The neglect of both theory and practice must surely be responsible for these suggested color processes. It is interesting to note that we meet with a similar visual breakdown when we try to combine two quite dissimilar monochrome images. Even when they are simple regular line patterns we do not see the two combined to form a more complex regular pattern. All we see is sometimes one pattern and sometimes the other, while these appearances alternate with glimpses of what appear to be broken bits of each pattern. Wheatstone attempted an explanation which practically amounts to suggesting that the brain is inattentive to intelligence sent to it through the eyes when the two eyes simultaneously tell quite different tales. When we meet with two witnesses who spin quite different yarns, and both talk at the same time, the only thing to be done is to separate them, and make each tell his tale by himself, and it is quite reasonable to assume that this is what the brain does when its scouts the eyes contradict one another. It then studies the subject through the medium of each eye alternately until some general idea is obtained.—The British Journal of Photography.

According to the Electrical Review (London) the Admiralty have decided to erect a wireless telegraph station at Wick. An acre of ground has been leased, and provision will be made for a staff of twelve men. The station is to be equipped with the latest appliances for long-distance communication, and is expected to be in working order early next year. It is reported that the airship "Zeppelin III" has been proved capable of communicating by wireless telegraphy with stations at a distance of 300 miles. Nevertheless the experts consider that to insure successful communication wood must be substituted for aluminium in the construction of the frames of airships of the rigid type.

THE NON-MAGNETIC SHIP "CARNEGIE."*

A VESSEL WITHOUT IRON OR STEEL.

BY E. A. DIXIE.

THE NON MAGNETIC SURVEY YACHT CARNEGIE

NEVER since the Bronze Age (and probably not even then) until the building of the Carnegie has a vessel of this size been made without wrought iron or mild steel in her construction and equipment

Her displacement is about 600 tons and there is no wrought iron or mild steel and less than one pound of cast iron, in her construction for each ton displacement

THE ENDOWMENT OF THE CARNEGIE INSTITUTION

January 28th 1902 Andrew Carnegie gave to a board of trustees $10 000 000 in registered bonds yielding 5 per cent annual interest On December 10th 1907 he added $2 000 000 to this With this endowment the institution was originally organized as the Carnegie Institution Later it was incorporated by an act of Congress approved April 28th 1904 under the title Carnegie Institution of Washington

OBJECT OF THE INSTITUTION

The object of the institution is the promotion of investigation in the broadest and most liberal manner Many projects in widely different fields of inquiry have been considered or are under consideration Among these is the department of terrestrial magnetism founded April 1st 1904 of which Dr L A Bauer, The Ontario Washington D C is in charge

For the pursuit of the investigation of terrestrial magnetism the 'Carnegie has been built

A TRIAL MADE WITH A PARTIALLY NON MAGNETIC SHIP

The first vessel used for survey purposes was the 'Galilee,' a vessel which was chartered and adapted as well as conditions would permit

She made a general magnetic survey of the Pacific extending from the Aleutian islands on the north to New Zealand on the south, Asia on the west and the Americas on the east Her cruises aggregated [illegible]0 000 miles and extended from August 1st 190[illegible] to June 1st 1908

Owing to the fact that iron and steel both magnetic metals enter largely into the construction of ships sensitive magnetic instruments are liable to the influences of such iron and steel parts, and accurate readings of such instruments are not possible when such local attraction exists The Galileo was stripped of magnetic fittings wherever possible but it was obviously impossible to remove all iron and steel from a vessel already built and built without the knowledge that she would some day be devoted to this magnetic research work The results obtained with her were however so unsatisfactory (errors of 4 to [illegible] degrees being found in charts) that it was decided to build a vessel as nearly not magnetic as possible and this decision resulted in the launching of the 'Carnegie on the 12th of June 1909 her keel having been laid in the middle of February 1909

WHY THE COMPASS DOES NOT ALWAYS POINT NORTH

It is now well known that the compass or magnetic needle points true north and south at but few places on the earth In all other places it points either east or west of true north

In the United States there is a long narrow belt running approximately through Columbus Ohio and Columbia South Carolina where the north end of the compass at present points either exactly or nearly true north I use the term at present because the magnetic pole is not fixed in position but is at present apparently moving westward This change is called 'secular variation and amounts to as much as ten degrees or more in a century

To give an idea of the variation of the compass in the United States from Maine on the east to Washington on the west it would be found that north as indicated by the compass would vary from 20 degrees west of north to [illegible] degrees east of north in those two States respectively

THOSE DIRECTLY INTERESTED AND WHY

The mariner the surveyor and the explorer rely upon the compass or magnetic needle to guide and serve them for their purposes They must hence have charts showing how the compass points at all parts of the globe and by what amount it changes from year to year In the existing charts of the oceans the latitudes and longitudes the depths the directions and speeds of currents and variations of the compass etc are put down for the mariner's guidance The variations as set down in these charts are known to be incorrect and the supplying of true magnetic charts and compass data is one of the chief objects of the magnetic survey and incidentally of the Carnegie

If one were to start from New York city with a compass in hand and follow the direction pointed by the north end of the needle he would be led across Lake Ontario into Canada along the east side of James Bay across Hudson Bay in the direction of Boothia Felix in Arctic North America where the north magnetic pole seems at present to be situated As he approaches this point the needle would become more and more fickle and less and less inclined to point in a definite direction Right at [illegible] above the magnetic pole it would point in any direction and would be no more use for telling direction than a ham sandwich

ANOTHER INSTRUMENT USED BY MAGNETICIANS

Thus we see the force exerted by the earth as a magnet upon the compass becomes less and less as the magnetic pole is approached, and at this point its indication, while still extant, is because of apparent lack of direction of no value to the observer. However, the magnetician is fortunately not dependent upon the compass alone; [illegible] has another instrument, the dip circle or dipping needle, as it is commonly called. This is practically a compass needle hung on a horizontal instead of a vertical axis. The needle is thus capable of swinging in a vertical plane. The needle of the dip circle would at the magnetic poles stand exactly vertical.

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* By courtesy of the American Machinist.

Thus we see why the compass needle becomes so inert at the magnetic poles, for the magnetic force is all exerted at this point in a vertical direction.

[illegible]

Half way between the magnetic poles there is a line similar to the geographic equator, but not coincident with it, called the magnetic equator. The magnetic equator intersects the geographic equator at various points, and along this line the dip needle would lie precisely horizontal.

[illegible]

As the compass approaches the magnetic poles the vertical pull [illegible] pull or dip [illegible] does the dip needle. [illegible] compass needle is [illegible] by a small adjustable weight attached to the opposite end of the needle. Thus in the north magnetic hemisphere the weight would be on the south pole of the compass needle. How much the needle dips at various parts of the earth and the amount of dip and the change in dip from time to time will be another task for the magneticians to determine.

I might fill this issue of the American Machinist from cover to cover telling the various known problems which it is intended that the magnetic surveys shall solve, and then the story would be but partly told, for in all research work discovery leads on in an endless chain to other discoveries. One peculiar fact is known about the magnetic poles: they are not antipodal to each other, and a straight line connecting them would miss the center of the earth by about [illegible] miles, or about one-fifth of the earth's radius. This gives a reason for the very irregular distribution of magnetism throughout the earth.

THE EARTH A GIANT MAGNET

The earth is thus shown to be a gigantic magnet, and is capable, the same as other magnets, of communicating magnetism to other magnetizable bodies on its surface. Previous to the advent of iron and steel in ships this phenomenon did not make itself particularly obnoxious, but since these metals have become the principal ones used in naval construction it has been found that if an iron ship is built on stocks running north and south it becomes a permanent magnet, and its influence on the compass is likely to [illegible] its navigator under [illegible] if not [illegible]. The setting of the magnetism in the ship is also aided by the vibration due to the setting up of the rivets with hand and pneumatic hammers. For this reason all shipyards, or at least all stocks for metal ships, are built approximately east and west. This same peculiar tendency to become permanent magnets is noticeable to a marked degree in steel and iron ships taking long voyages in a generally northerly or southerly direction. In any case, no matter what direction an iron vessel sails, the magnetism of the ship is forever changing.

THE NONMAGNETIC VESSEL

The "Carnegie" combines the seaworthy qualities of an ocean-going vessel with the neat trim appearance and comforts of a private yacht.

Her hull was designed by Henry J. Gielow, engineer and naval architect, [illegible] Broadway, New York, who is himself an amateur scientist of no mean ability. Thus the designing of her called from him not only his best efforts as a designer of ships, but the interest and enthusiasm of the scientific devotee.

THE BUILDER OF THE "CARNEGIE'S" ENGINE

The engine was designed and is being built by James Craig, Jr., [illegible] West Thirty-fourth Street, New York, who designed and built the internal-combustion engines for the submarine boats "Octopus," "Cuttlefish," etc., and except for the necessary variations caused by the use of producer gas instead of gasoline, and the use of nonmagnetic metal, is the same as the engines installed in the submarines.

THE BUILDER OF THE "CARNEGIE"

The "Carnegie" was built at the foot of Twenty-third Street, Brooklyn, under the supervision of Wallace Downey, president and manager of the Tebo Yacht Basin Company, by William H. Payne, constructor. In passing I may mention that the famous yacht "Meteor," built for the Emperor of Germany, and the three-masted schooner yacht "Atlantic," built for Wilson Marshall of Bridgeport, Conn., and which won the Emperor of Germany's gold medal in the international transatlantic race in 190[illegible], were both built by these two men.

RESTRICTIONS PLACED ON THE MATERIALS

Owing to the stringent restriction placed on the admission of magnetic material into the construction of this vessel, a very sensitive instrument was installed at the yard to test all metals entering into her construction. To give an idea how sensitive this instrument is: if you were to take an ordinary pocket knife and hold it [illegible] feet away from the instrument and then merely turn it end for end, the indicator of the instrument would wag five or six degrees.

The hull of the "Carnegie" is of wood, which is fastened together with tree nails (which are wooden spikes driven into bored holes; these tree nails are usually made of locust wood) and bolts and spikes of manganese bronze. Where thin wood and canvas are to be fastened, copper and bronze nails and tacks are used. Every bolt, spike and nail has been tested for magnetism, and it is a noteworthy fact that out of the many thousands of metal fastenings used but seven spikes have failed to pass inspection.

HER DIMENSIONS

The "Carnegie" is [illegible] feet [illegible] inches over all, [illegible] feet beam, has a depth of hold of [illegible] feet [illegible] inch, and a mean draft of 1[illegible] feet [illegible] inches. With all stores and equipment on board her displacement is 568 tons.

The keel, stem, stern post, frames and deadwood are of white oak grown, cut and sawed at Jamaica Plains, Greater New York, within twelve miles of the shipyard where she was built.

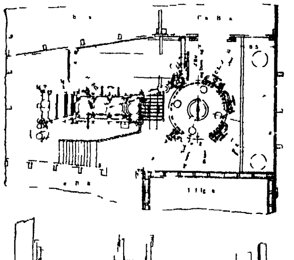
The deck beams, planking and ceiling are of yellow pine, and the deck is of Oregon pine in long lengths. The keel is 12 x 18 inches, and to this is fitted a false keel 1[illegible] x 4 inches.

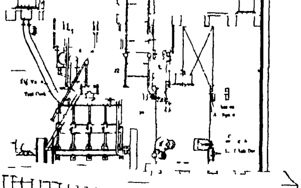
HER RIG

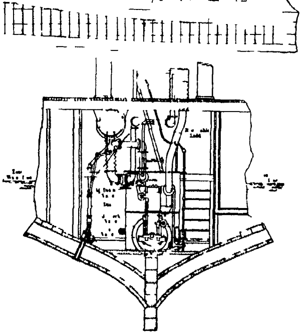
She is brigantine rig (what this means can be seen by referring to Fig. 1), and spreads 12,900 square feet of plain sail. From the foremast truck (the top of the front mast) to the water surface is 1[illegible]2 feet, and from the forward end of the bowsprit to the after end of the main boom is [illegible] feet.

The rigging is of Russian hemp of special make.

It was decided to install auxiliary propulsion in the "Carnegie" so as to provide headway when taking offshore observations, when the vessel could be with difficulty handled by the sails, and to prevent interruptions in the observations by maintaining headway during calms.







PRODUCER PLANT AND ENGINE

WHY A PRODUCER-GAS ENGINE WAS CHOSEN

The necessity of providing means of propulsion which would be nearly nonmagnetic in character made the type of plant somewhat difficult of selection.

The only type of prime mover which could be built at a reasonable price and maintained in reliable operation with a minimum amount of nonmagnetic metal in its construction appeared to be an internal-combustion engine.

Consideration of the available fuel for such a motor resulted in the elimination of gasoline or oil, not only on account of cost, but also because it would be impossible to procure them in the zone to be covered by the "Carnegie," as well as being dangerous in the quantities which would have to be stored for the lengthy voyages which are contemplated. It is well known that many thousands of horse-power are being developed with internal-combustion engines on land using gas generated from solid fuel. A careful investigation showed that a gas producer for marine purposes could be built which would generate producer gas for use in internal-combustion engines from bituminous or anthracite coal, coke, wood or charcoal, and that such a plant could be constructed almost entirely of nonmagnetic material. The suction type of gas producer was adopted principally for the reason of its simplicity in construction and operation, and the elimination to a minimum degree of other auxiliary apparatus.

POWER PLANT AND CRUISING RADIUS

The "Carnegie" is equipped with a four-cylinder Craig internal-combustion engine of 1[illegible]0 horse-power, shown in Figs. 2 and 3. The gas producer shown in Fig. 4 is furnished by the Marine Producer Gas Power Company of New York, and consists of a cylinder 6 feet high with a diameter of [illegible] feet 6 inches, built of copper with asbestos and firebrick lining and manganese steel grates. Anthracite coal will be used as fuel, the gas to be generated in the producer and taken to a special scrubber of copper, from which it passes to the internal-combustion engine. The vessel will carry [illegible] tons of coal in her bunkers, which will give her a cruising radius of 2,000 nautical miles at six knots.

EQUIPMENT

The ground tackle comprises four bronze anchors of special design: two anchors of 1,900 pounds each, one of 1[illegible], and a kedge anchor of [illegible]0 pounds; three 11-inch hemp cables, each 127 fathoms in length, are required for these anchors, as no satisfactory nonmagnetic chain was obtainable. The hawser pipes are of bronze of special design, and the boat davits and all metal deck fittings and chain plates are of special bronze. The boat equipment consists of two nonmagnetic gigs. A refrigerating plant constructed of bronze and copper, operated by a six-horse-power special engine, forms a necessary part of the equipment for a vessel which at times will be a month or more continuously at sea. All living quarters are below, the sailing officers' and crew's quarters being forward, after which are the quarters for the scientific staff mentioned, in the machinery space. The living quarters are especially planned with a view to giving good accommodations for all. There will be two galleys, one for the scientific party and the other forward for the crew. Specially designed cooking ranges of bronze and copper have been provided.

WHERE THE OBSERVATIONS WILL BE TAKEN

Of special interest is the observation room located on the main deck amidship, forward and aft of which are circular observatories with revolving domes not unlike those of astronomical observatories. It will thus be possible to take magnetic observations both in the open and under shelter inside these observatories. The positions of the stands for the various instruments have been so chosen that any effect resulting from the amount of iron in the machinery (about 500 pounds, 30 feet from the instruments), which could not be replaced by nonmagnetic material, would be so small as to be negligible. With regard to the engine itself, the cylinder castings, which are usually made of cast iron, have been made of special bell metal composed of 80 per cent copper and 20 per cent tin. This metal is so hard that it took seven cuts to finish a cylinder. It has been found that the gas carried over from the producer plant sometimes contains sulphuric acid, but this metal will resist its action. The balance of the engine is of special bronze. Owing to the weakness of producer gas the compression space in the engine has been altered. With the ordinary run of gasoline engines the compression is about 75 pounds per square inch; with the producer gas it is necessary to almost double this. For the same reason given above, the valves and induction pipes have been increased to twice the area of valves and induction pipes used in gasoline engines. A special sparking device must also be used, as the ignition for producer gas must be most pronounced.

MAGNETIC METAL USED

The only parts of magnetic metal used in the engine are the pistons and piston rings, which are made of cast iron Nickel steel is used for the cams and valves When the question of making the pistons first came up bronze was suggested, but as this is so brittle at high temperatures it was not considered available The next metal suggested was manganese steel but this is very difficult to cast and the makers said that they might cast as many as twelve pistons without getting a good one Another great difficulty with manganese steel is machining it It cannot be finished with anything but an abrasive wheel

PECULIAR FACTS ABOUT NICKEL STEEL

Mr Craig then suggested nickel steel and wrote to the Bethlehem Steel Company one of the makers of this metal They told him that a 25 per cent nickel steel would be practically non magnetic and he submitted this information to the Carnegie Institution at Washington They informed Mr Craig that while it was true that 25 per cent nickel steel was not magnetic if it were allowed to reach as low a temperature as 30 deg F it would become magnetic and retain it until it was heated to a temperature of about 100 deg F

Sheath knives of sailors are as a rule made of carbon steel but for the sailors of the Carnegie special knives of manganese steel have been made which are practically non magnetic If a piece of soft iron is rated as 100 a piece of manganese steel would show only about 1 per cent of magnetic attraction What will be done regarding the material for the carpenter's tools has not yet been settled

THE DIFFERENT PHASES OF MATTER.

In an article published in the Revue Générale des Sciences, M C E Guillaume of the International Bureau of Weights and Measures has reviewed the recent work on the different states of matter Just as Andrews proved that there was no real discontinuity between the liquid and gaseous states MM Tammann Spring and others have shown that there is not necessarily a discontinuity between the solid and liquid phases of a body Experiment shows for instance that an amorphous solid has no definite melting point though a crystalline solid has Solid water has commonly a crystalline structure but by cooling it to [illegible] deg, and at the same time submitting it to a pressure of 2 000 to [illegible] 000 atmospheres Tammann found that the ice was converted into a new variety of solid water denser than ice which would apparently be the stable form even at 0 deg under a pressure of 10 000 atmospheres Kahlbaum again submitting samples of ordinary metals to a hydrostatic pressure, which in some cases was as much as 20 000 atmospheres found that these samples were converted into a solid less dense at ordinary pressures than the ordinary form The specimens generally altered also in shape shortening or lengthening as the case might be and their surfaces lost their polish Other experiments in wire drawing made by Spring confirmed these results In general wire drawn metals proved less dense than normal samples Bismuth however proved an exception its density being augmented Generally this metal is extremely weak and brittle but when extruded as a wire through a small orifice by great pressure the wire proved quite flexible and could be tied into a knot without the slightest tendency to break M Guillaume remarks that these experiments lead to the conclusion that all solids under heavy pressures tend to be converted into an amorphous state which has no discontinuity with the liquid and gaseous phases At the pressures met with a few miles below the surface of the earth the rocks or other material are at once fluid and yet as rigid as steel They will flow under the slightest lack of symmetry in the forces acting on them though their viscosity is of course enormous and hence enormous lapses of time are necessary for large movements He suggests that the conditions met with in the interior of the globe may suffice to account for the production of radio active elements by a process of synthesis If the enormous pressure obtaining in the interior of the globe is the cause of the formation of uranium then the radioactivity of the latter is merely a restitution of a small portion of the energy liberated on the condensation of our globe The fact that pressures of 2 000 atmospheres have been found to have no apparent influence on the radio activity of radium does not in his view provide a conclusive argument against the hypothesis advanced since this pressure is small relatively to those existing in the interior of the earth —Engineering

COLOR ACTION OF METALS IN ALLOYS.

LEAD deepens the color of copper alloys It is largely used to assist the copper in red metals and also to give gun metal a more coppery appearance than the actual copper content alone would produce

Zinc improves the casting qualities of copper alloys but has quite the opposite effect on the color that lead has

Aluminium gives a mottled surface due to crystallization of that element One per cent added to yellow brass produces a good imitation of pale gold

Phosphorus by closing the grain, allows of a higher polish on all alloys

Arsenic has a similar effect but it is now only used for speculum

Bismuth and manganese produce rose tinted effects and improve the luster Bismuth has a powerful effect on all the white colored metals giving a warm tone to German silver alloys containing zinc tin or aluminium

Antimony has a similar result as regards color but it is a dangerous element in alloys requiring strength The cohesive force of antimony is poor

Copper added to white alloys gives increased luster greater ease in tooling and better casting qualities

Mercury about 1 to 1[illegible] per cent added to the standard ordnance bronze copper 90 tin 10 produces a beautiful rose pink tinted metal which makes fine contrasts with other gun metal brass or silver old castings Great care must be exercised in adding the mercury to the barely molten tin intended for the bronze mixture

Venus metal an alloy of equal parts of copper and antimony is a beautiful violet colored alloy It polishes well but is too brittle for delicate parts of a design

An alloy used for objects of art and which resembles fine gold consists of copper 92 parts aluminium 6 parts gold 2 parts J F Buchanan in The Foundry

ELECTRIC WIRES OF ALUMINIUM

HITHERTO copper has been employed exclusively for electric wires whether aerial underground or submarine because of its great conductivity which surpasses that of any other metal except silver Within recent years the price of aluminium has fallen so low that it may be advantageous to substitute it for copper in many cases Aluminium which now costs only 11 cents per pound owing to the large stock accumulated and the establishment of new and extensive producing plants since 1[illegible]0 no increase of price is to be feared The properties of copper and aluminium are compared in the following table

	Hard Copper	Aluminium
Density	8 9	2 7
Coefficient of expansion by heat	0 000016[illegible]	0 000023
Maximum tensile strength in tons per square inch	27 to 31	13 to 14
Limit of elasticity in percentage of tensile strength	10 to [illegible]0	[illegible] to 60
Elongation per cent	2 to [illegible]	4 5
Ohmic resistance of a wire one meter long and one square millimeter in section at 1[illegible] deg C	0 0175	0 030
Coefficient of the increase of resistance with temperature	0 00[illegible]9	0 010

Hence the ohmic resistance of a copper wire equals that of an aluminium wire of cross section 1[illegible] times greater the substitution of which would result in a saving in weight of [illegible]8 per cent In order that the two wires of equal resistance should cost the same the price of copper must be only about one half of that of aluminium The deficiency of aluminium in tensile strength is largely compensated by its lightness so that spans of the same length can be used for both metals Aside from the question of first cost the employment of aluminium for aerial lines presents the following advantages and disadvantages

I Effect of Wind—The aluminium wire is more affected by wind because of its greater size but this is of no importance with wires carried on wooden poles which always have more than sufficient transverse strength for the usual spans of 130 to 1[illegible]0 feet On very small (telephone) wires however the effect of the wind is too great to permit the employment of aluminium

II Effect of Snow and Ice Although the aluminium wire is larger than the copper it does not become more heavily coated with snow and ice as the quantity of these deposits is found to be independent of the size of the wire

III Joints The making of joints offers the chief difficulty in the employment of aluminium Welding with the blowpipe is hardly practicable The wires must be joined by rivets splices cylindrical junction pieces or clamps A well made splice is generally quite sufficient

IV Wiring—The operation of wiring is much more easily and quickly accomplished with aluminium because of its lightness Fewer workmen are required and no horse is needed to stretch the wire

V Effect of the Atmosphere—The aluminium should be almost pure as it is now produced in France and the United States The failure of the first attempts to use aluminium wire was due to the employment of impure metal With pure aluminium cases of corrosion are rare and they are found to be due to smoke or chemical vapors which would have had the same effect upon other metals Aluminium is easily attacked by alkalies and chlorine and should not be used near chemical factories Sea air does not appear to have any marked action for the metal soon becomes covered with a coating of alumina which affords far better protection than the hydrated carbonate formed on copper wires

VI Insulated Cables Here the conditions are less advantageous as the greater size of the aluminium cable increases the quantity of insulating material required by [illegible]0 per cent On the other hand the heating is only three quarters and the weight one half that of copper for which at present prices aluminium could be substituted with advantage especially for high tension cables which require heavy insulation It has been demonstrated that when the thickness of the wire is increased the thickness of the insulation can be diminished Apt by experiments with tensions of 20 000 30 000 and 10 000 volts has proved that the superiority of aluminium increases with the voltage

Many aerial aluminium wires are already in use in France the United States and Canada The French cables carry from [illegible]0 000 to [illegible]0 000 volts

TEHUANTEPEC AND PANAMA TRANS-ISTHMIAN TRAFFIC BY RAIL

More than $[illegible]0 000 000 worth of American merchandise was carried by rail across the isthmuses of Panama and Tehuantepec in the fiscal year 1909 and in the calendar year which ended with December the total will probably reach $7[illegible] 000 000 in value Of the two railways which now carry freight across the narrow neck of land connecting North and South America that at the Isthmus of Panama is [illegible] miles in length the other at the Isthmus of Tehuantepec 190 miles The one at Panama owned by the government is of course largely devoted to work and traffic growing out of the construction of the Panama Canal the other at Tehuantepec 190 miles in length constructed chiefly with British capital and controlled in part at least by the Mexican government was built especially for the purpose of handling freight between the Atlantic and Pacific and although opened at the beginning of 1907, already has carried about $100 000 000 worth of merchandise passing chiefly between the Atlantic and Pacific ports of the United States Reports received by the Bureau of Statistics of the Department of Commerce and Labor show that the Tehuantepec Railway which crosses the Isthmus at Tehuantepec in the southern part of Mexico carrying the freight received from the steamship lines plying between the great ports of the United States and its eastern and western termini carried in the first year of its operation 1907 between $2[illegible] 000 000 and $[illegible]0 000 000 worth of merchandise in the second year 1908 nearly $[illegible]8 000 000 worth and in the present year will exceed $[illegible]0 000 000 in the value of freight carried by it The Panama Railroad engaged chiefly as above suggested in work in behalf of the Panama Canal carried in 1907 about $12 000 000 worth of merchandise originating in the United States and bound either for other parts of this country or for foreign countries in 1908 about $9 [illegible]00 [illegible]0 worth and in 1909 will show about the same total The merchandise passing over the Isthmian railways in the year ending June [illegible]0th 1909 included $[illegible]6 000 000 worth originating on the eastern coast of the United States and destined for Pacific ports including both the United States and foreign countries bordering on the Pacific and $26 000 000 worth originating on the Pacific coast and at the Hawaiian Islands and destined for the eastern ports of the United States Of the merchandise crossing by way of the Panama Railroad $[illegible] 000 000 worth moved from the Atlantic to the Pacific and a little less than $[illegible] 000 000 worth from the Pacific to the Atlantic Of the $9 000 000 crossing from the Atlantic side to the Pacific coast by the Panama line $1 000 000 were destined to the western ports of the United States and $[illegible] 000 000 to foreign countries located upon the Pacific coast of America The business of the Tehuantepec line although much larger in its value than that of the Panama route included chiefly merchandise moving between the eastern and western ports of the United States and the Hawaiian Islands Of the nearly $[illegible]2 000 000 worth of merchandise passing over the Tehuantepec line in the fiscal year 1909 over $24 000 000 worth moved from the Pacific end destined to ports on the eastern coast of the United States and $27 000 000 worth moved from the eastern end destined for Pacific ports Of the $[illegible] [illegible]00 000 worth of merchandise received at the Pacific terminus of the Tehuantepec road over $18 000 000 worth was from Hawaii being almost exclusively sugar for the refineries of Philadelphia and New York while over $[illegible] 000 000 worth originated on the Pacific coast chiefly at San Francisco being composed of miscellaneous merchandise Of the $27 000 000 worth passing westwardly over the Tehuantepec line $[illegible] 000 000 was sent to ports on the Pacific coast San Francisco San Diego and Seattle—and $3 000 000 worth to Hawaii New York and San Francisco are the chief centers for this ocean and transisthmian traffic between the eastern and western coasts of the United States —Railway and Engineering Review

HOW MAN ACQUIRED HIS FIVE FINGERS.

A HAND IS BUT A PROMOTED FIN.

BY CARL W. NEUMANN.

The history of civilization has been defined as the history of the human brain and hand. The brain is the master, the hand is the servant, and both together have conquered the world. In accepting this concise definition we must take care not to estimate too lightly the share of the hand in the work of conquest. In the whole history of life probably the final and decisive victory has always been won by the greater intelligence, and there can be no doubt that the creature endowed with the largest and most efficient brain would have made himself lord and master of all his fellow creatures even without the aid of the hand. But perfect adaptation to terrestrial conditions, ability to live amid polar ice and under the scorching tropical sun, to rise in the air like a bird and to descend into the depths of the sea like a fish, to overcome obstacles and make them subservient to his purpose, in short the development characteristic of civilized man could never have been acquired by the most gigantic of brains without the assistance of the hand.

The history of human culture began with the invention of tools, when the hunter of the mammoth of the ice age first formed a weapon by chipping a flint, and civilization has increased in proportion to the improvement in toolmaking. The hand that made an axe by chipping a flint and adorned the walls of caves with rude drawings of animals subsequently created the Venus of Milo and the Sistine Madonna, erected palaces and cities, constructed railways and steamships and airships, always under the direction of its master, the brain.

Hence it is not surprising that the human hand as well as the human brain was long regarded as representing the highest stage of organic development. But this view has been found erroneous by paleontology, i. e., the science of extinct animals and plants.

In 1833 large footprints of peculiar form were discovered in the sandstone of Hildburghausen. Ages ago a very heavy animal must have walked over this spot and impressed its feet deeply in the mud which subsequently hardened into stone. At a still later period a second layer of mud flowed over the first and hardened in turn, so that both the negative and the positive impression, or the mold and the cast of the animal's feet, have been preserved in the two strata. There is nothing wonderful in this process and its results. The remarkable circumstance is the striking resemblance of the large hind feet as well as the small fore feet of the animal to human hands with a thumb opposable to the other fingers, the various joints of which are clearly discernible in the impressions.

Many similar footprints have since been found and every paleontological museum contains specimens of them, but no bones or other remains of the animal have been discovered. The mysterious creature which has been named Chirotherium ("hand animal") apparently left nothing except its footprints on the sands of time.

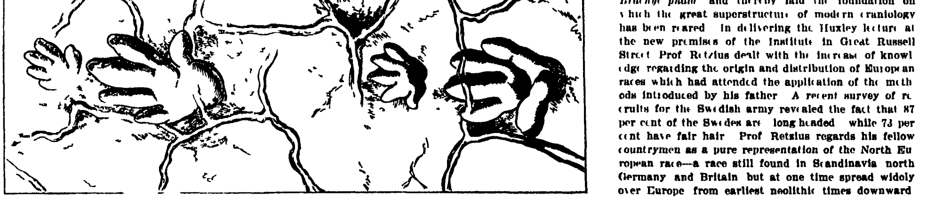


FIG. 1. FOOTPRINTS OF CHIROTHERIUM.

But although later paleontological researches have contributed nothing to our knowledge of the Chirotherium, they have contributed greatly to the history of the hand. We now know that prehensile hands with a thumb opposable to the other four fingers were possessed not only by the Chirotherium but also by various lower mammals and amphibia and by the monstrous dragon-like saurians *of remote ages. Hence* the hand is not the exclusive possession of man and cannot be regarded as representing the highest stage of development.

The most important acquisition, however, is the knowledge that the extremities of all terrestrial vertebrates are constructed upon a uniform plan with *five parts, one of which is opposable to the other four*. Whether the original hand or foot has been developed (or degraded) into the claw or wing of a bird, the wing of a bat, the fin of a walrus, the single hoof of a horse, the double hoof of a goat, the triple hoof of a rhinoceros or the quadruple hoof of a hippopotamus, the farther backward the ancestral history of any of these varied forms is traced the more closely does the member resemble the human hand with its five *fingers*.

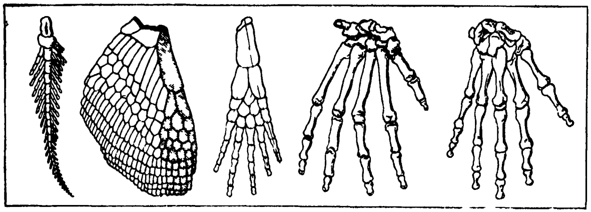


FIG. 2. EVOLUTION OF THE HUMAN HAND FROM THE FIN OF A MUD FISH.

The logical conclusion is that all of the higher vertebrates are descended from a common group of ancestors having five-fingered extremities and opposable thumbs. This group must be older than the Chirotherium, whose footprints are found in the Triassic rocks. In the Carboniferous period, hundreds of thousands of years earlier, the dense forests harbored many five-toed amphibia, whose skeletons now adorn our museums. Hence the hand with five fingers must have existed in a still earlier period, the age of fishes, before land animals had been developed.

Can the human hand have originated in the fin of a fish? Science answers Yes, and points to a very interesting amphibious creature, the Australian mud fish (*Ceratodus*), which has been called a living fossil because it is the sole remaining representative of a group of animals that flourished in the beginning of the Carboniferous period. The Ceratodus possesses *two systems of respiratory apparatus*. In the rainy season, when the bed of its native stream is filled with water, it breathes through gills like a true fish, but in the dry season it breathes through lungs like a land animal. These amphibious fishes apparently represent a stage of transition from aquatic to terrestrial forms of animal life, and among them the possessor of the first five-fingered hand must be sought.

The celebrated comparative anatomist Karl Gegenbaur proved that the spines or rays of a fish's fin correspond morphologically with fingers or toes. The fins of most existing fishes contain many rays and are very complex and highly developed swimming organs, but the fins of Ceratodus and its extinct near relatives are very much simpler. It resembles a fern leaf or a feather and is composed of a single stout cartilaginous midrib, which bears on each side a number of slender jointed appendages.

The Ceratodus has four of these primitive fins, which *appear predestined to develop into legs*, and upon them it often raises its body from the bed of the stream.

If some of the mud fishes of the Devonian period habitually used their fins as legs and walked on them, the midrib of the fin and such branches as proved especially useful in walking would have been preserved and strengthened in their descendants, while the other branches would have been eliminated by disuse. The result would be a foot with a larger or smaller number of toes. The number five, which forms the original basis of subdivision of the feet and hands of all the terrestrial successors of the mud fishes, must have proved most advantageous, for some reason yet unknown.

The evolution of the human hand is illustrated by Fig. 2. The first illustration (on the left) represents the fin of the Ceratodus and the extinct mud fishes. The second illustration represents the pectoral fin of a less ancient fish from which, according to Gegenbaur, the five-fingered member of the amphibia, reptiles and higher vertebrates was developed by the elimination of the parts which are not shaded in the illustration. Gegenbaur's circuitous method is rejected by later biologists, who assume simply that the midrib of the primitive fin became a thumb and four of the appendages on one side became fingers, as is indicated by the dotted lines in the third illustration, which represents the hand of amphibia. The skeleton of a gorilla's hand is shown in the fourth and that of a human hand in the fifth illustration.

Whatever the exact *course of evolution may have* been, it appears evident that our five-fingered hands, to which we owe our decimal system of arithmetic, are inherited from Devonian mud fishes that lived millions of years ago.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Reclams Universum.

THE FATE OF THE LONG-HEADED BLOND RACE

The Royal Anthropological Institute of Great Britain and Ireland was particularly happy in its choice of Prof. Gustav Retzius of Stockholm as Huxley lecturer for the current year. He is a son of Anders Retzius, who in 1840 divided mankind according to the shape of their heads into *Gentes Dolichocephalæ* and *Gentes Brachycephalæ*, and thereby laid the foundation on which the great superstructure of modern craniology has been reared. In delivering the Huxley lecture at the new premises of the Institute in Great Russell Street, Prof. Retzius dealt with the increase of knowledge regarding the origin and distribution of European races which had attended the application of the methods introduced by his father. A recent survey of recruits for the Swedish army revealed the fact that 87 per cent of the Swedes are long-headed, while 73 per cent have fair hair. Prof. Retzius regards his fellow countrymen as a pure representation of the North European race—a race still found in Scandinavia, north Germany and Britain, but at one time spread widely over Europe from earliest neolithic times downward. They may be regarded as the aborigines of Europe, not, as at one time widely believed, Aryan invaders from Asia. Prof. Retzius agrees with those who take a gloomy view as to the future of this ancient race. The qualities which made them great in the past are just those that unfit them for the routine life of an industrial civilization. The round-headed, dark-haired race which has replaced them in central Europe has gained its victory by the possession of superior industrial qualities, a superiority that threatens ultimately to overwhelm the fair-haired northern European stock. *Prof. Retzius is not one of those* who believe that an industrial mode of life can alter the shape of the head or color of the hair, the evidence in support of such a hypothesis is altogether unconvincing. Such questions of the very greatest importance to industrial nations can be settled only by a comprehensive physical survey of the people.—Lancet.

ANOMALIES OF VISION.

SOME CURIOUS ILLUSIONS.

BY A. GRAEF.

THE ease with which erroneous judgments are formed from ocular impressions is strikingly illustrated by a common experience of bicyclists traveling along a straight road through a rolling country. In toiling up a hill the bicyclist is prone to cherish a fallacious hope that beyond the summit he will find a down grade suitable for easy and exhilarating coasting. In going down hill, on the contrary, he feels sure that after reaching the bottom he will be compelled to climb a steeper hill than he actually finds there. In each case he discovers his error before he has reached the top of the hill or the bottom of the valley. The second error is commoner and more marked than the first, and both are increased when the road is bordered by trees which conceal much of it from view. The liability to error is less when the road is curved.

The traveler, in ascending a hill and looking ahead, apparently sees the row of tree tops beyond the highest point sink very rapidly below the level of that point, and concludes that the hill falls very steeply on the farther side. But the distant trees really sink, not below the level of the top of the hill, but below the prolongation of the ascending line drawn from the traveler's eye to the highest visible point of the road. This is illustrated by Fig. 1 *A*, in which *a* is this highest visible point, *o* the eye, and *o a b* the inclined line of vision, below which nothing can be seen. The traveler, however, is apt to assume that his view is limited, not by this inclined line, but by the horizontal line *a d*. Hence, assuming the trees to be of equal height, he pictures them and the road as indicated by the dotted lines in Fig. 1 *A*. In this, as in most cases, the highest visible point, *a*, is not the top of the hill, so that the road immediately beyond *a* actually ascends, but it appears to descend slightly, carrying with it the house which crowns the hill, the lower part of this house being below the line of vision. The error is intensified by the effect of perspective, which shortens the more distant part of the row of trees and therefore makes it appear to descend still more sharply (Fig. 1 *B*) and the concealment of the surface of the ground by the small prominence at *a* removes the usual means of correcting the error due to perspective.

The overestimation of the steepness of a hill which is approached along a down grade is due to similar causes and admits of a similar explanation. The hill, indeed, may exist only in the traveler's imagination. The road may appear to rise beyond the steep descent, though it is actually level or even slightly descending.

When we look at a point which is lower than the eye we estimate its depth below the eye of the angle between the horizontal and the line of sight which leads to the point. The smaller this angle is, i. e., the smaller the effort required to raise the eye from the point to the horizon, the higher is the position which we ascribe to the point. But as the point, without change of level, recedes from the eye, this visual angle diminishes. Hence a distant point appears higher than a near point on the same level. Thus to an eye at *o* (Fig. 2) the point *b* appears higher than *a*, *c* higher than *b*, and *d* higher than *c*. In other words, the horizontal line *a b c d* seems to rise as it recedes from the eye. This is a perspective illusion analogous to the apparent mutual approach of two receding parallel lines of posts or trees. For this reason a brook flowing sluggishly along a nearly level bed may appear, to an observer looking downstream, to flow up hill. From a tower erected on a wide plain the distant horizon appears higher than the ground near by, and the plain assumes the appearance of a vast shallow bowl. A German traveler, Von Binder-Krieglstein, has given a graphic description of this effect, as it is produced by the great llanos of Brazil upon an observer standing upon their highest elevations, which do not exceed 160 feet. This hollowing of the landscape is still more apparent to an observer looking from a balloon. Major Gross has observed that the apparent curvature increases with the height of the balloon, and with the thickness of the layer of mist which always covers the earth's surface. Sometimes the effect is so pronounced that a part of the horizon is seen above a low lying cloud. This appearance, with which most aeronauts are familiar, is due to atmospheric refraction. In general, the pencil of light which extends from an object on the earth's surface to the eye of an observer in a balloon traverses atmospheric strata of continually decreasing density as it ascends, and consequently assumes a curved form, with its concavity directed toward the earth. Hence the object is apparently elevated, the more so as its horizontal distance from the balloon increases, precisely as the immersed portion of an inclined rod partly covered with water appears to be bent upward. The apparent concavity of the ground is therefore increased by refraction, but this is not its sole cause, for the deceptive appearance is often produced when the elevation of the eye above the ground is too small to include any appreciable difference in the density of the air.

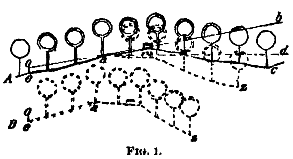


FIG. 1.

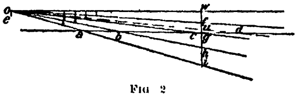


FIG. 2.

An illusion of similar character affects persons who live chiefly indoors and are not in the habit of looking straight ahead toward a distant horizon. Such persons often bend forward with their heads lowered. This attitude may affect their judgment of the horizontal direction, which they assume to coincide with some such line as *o u* (Fig. 3) instead of *o w*. Their horizon being lowered, the visual angles of low lying objects are diminished and every such object is elevated, to an extent proportional to its distance from the eye. This is indicated by the dotted lines of Fig. 3 *A*, while Fig. 3 *B* includes also the perspective crowding together of the more distant objects. Some such distorted view is obtained by the city dweller, who with his habitual relaxed bearing gazes down a country road from a hill top, but if he holds his head erect and looks forward horizontally the road appears to sink and stretch. This change in appearance proves that the former apparent elevation of the road was caused, at least in part, by the attitude of the observer. Sailors and persons who live on broad plains are, according to Von Binder Krieglstein, much less subject to this illusion than the inhabitants of cities and mountain regions. The degree of the error is influenced by various circumstances. The road appears to ascend more steeply when it is shaded by big trees, when the observer occupies an elevated post and when the landscape is uniform and monotonous. Alternations of forest and meadow, crops of different colors, fields and roads give evidence by which the erroneous judgment can be corrected. At a great distance from the eye, however, these details become indistinct and finally unrecognizable. Parts which are equally indistinct appear to be at the same distance from the eye, but the angular elevation increases with the real distance. The result is that the view appears to be bounded by a steep border. If the details of the landscape are obscured by fog or snow this border may rise at a comparatively small distance and a slight incline may present the appearance of a steep hill.

The apparent elevation of the horizon is most striking when a wide expanse of water is viewed from an elevated point. In some cases very peculiar effects are produced. On the southeast coast of Holstein is a peninsula, which is crossed by rows of sand hills, running from west to east. A road crosses these dunes and affords glimpses of the sea from several of the valleys. A stranger can hardly resist the impression that the sea is higher than the valley and on the point of submerging it.

It is extremely difficult to prove whether other persons are or are not subject to the same errors of this sort that an observer may have detected in himself. When questioned, the other person is apt to reply with a curt and careless negative or a polite and equally careless affirmative, according to his disposition. And the subject does not admit of elaborate discussion, as it concerns impressions which are purely personal and also erroneous. There is even danger that an introspective person whose attention has been called to the subject may create in himself erroneous impressions which did not previously exist. Of especial value, therefore, is the voluntary uninfluenced testimony of Von Binder Krieglstein and of persons who seemed to see water run uphill. The most valuable observations are those which are made unconsciously, in cases when the erroneous impression is so strong that the discovery of the truth produces a feeling of surprise.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

A CASE OF RAPID VARIATION OF AN INSECT SPECIES.

AN experiment performed by Marchal last year has reopened the question of the formation of a new species. The experiment was made with *Lecanium robiniarum*, a coccid which infests the acacia. The coccids form a family of hemipterous insects which includes the cochineal and kermes insects. The *Lecanium* resembles the cochineal insect, from which it differs chiefly in the curious life history of the female, which dies and becomes transformed into a sort of shield fastened tightly over the eggs and the leaf which carries them, so as to protect them very effectively. *L. robiniarum* has been known only about thirty years, and it was described as a distinct species in 1890 by Douglas, the leading authority on this subject. It is improbable that this species previously existed on the acacia, for as the insect is as large as a pea, it could not escape observation, both in Europe and in America, the home of the acacia. Hence it has been suggested that this species has been developed recently from another species of *Lecanium*. Marchal conjectured that this parent species was the very similar *L. corni*, which is a parasite of the peach, the rose and the grape vine.

According to Cosmos, Marchal placed on an acacia tree (taking proper precautions for isolation) a laying female of *L. corni*. The eggs were laid and the larvæ developed upon the acacia. When the insects had attained the adult stage four of them were found identical with *L. robiniarum*. Here, then, this type were certainly produced by *L. corni*. Marchal did not succeed in accomplishing the reverse transformation by placing *L. robiniarum* on peach trees, rose bushes or grape vines. He concludes from his observations that *L. robiniarum* is only a variety of *L. corni*. Such, indeed, is the common method of regarding such phenomena in systematic zoology, but the advocates of the theory of mutation prefer a different interpretation. Caullery and Mesnil see in this result an example of the formation of a new species by adaptation to new conditions. In the absence of experiments of this kind, the systematists had regarded *L. robiniarum* as an independent species, and it may be supposed that more than one species, distinguished by them, would give similar results if similar experiments were performed. The formation of a new type is furthermore a confirmation of the views of Lamarck. This experimental case, though very interesting, cannot settle the fundamental controversy between the advocates of fixed species and the transformists, but it may lead to a more precise definition of the characteristic elements of a botanical or zoological species.

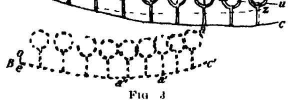


FIG. 3.

A type of Leclanché battery has been patented in France in which the present electrolyte of sal ammoniac is replaced by chloride of manganese. It is claimed that the cell holds up much better in this case, and that it can be short-circuited without harm. It has no consumption on open circuit. The internal resistance of the battery is low and it has a large effective yield. Besides, the liquid does not freeze in extreme cold. A novel feature lies in the fact that the exhausted battery can be regenerated by charging it by an outside current.

VENUS AND ITS PROBLEMS.*

ITS ROTATION AND ITS POSSIBLE LIFE.

BY T. J. J. SEE.

The question of the rotation of Venus presents great interest owing to two leading considerations.

(1) A rapid rotation of the planet on the axis which would give alternation of day and night, if not absolutely necessary for the development of life, would at least be highly favorable to the existence of animals and plants as known on the earth; and if such rotation could be assured for Venus, the outcome would go a long way toward establishing the habitability of the earth's twin sister in space.

(2) The question of the secular effects exerted by tidal friction in retarding the earth's rotation needs illumination from other sources; and of all the possible bodies to which we can appeal, this inner planet Venus presents the most favorable conditions for a satisfactory answer. It is the only planet whose rotation period would be likely to prove absolutely decisive for or against tidal friction as an effective cause in modifying the rotations of the bodies such as we find in the solar system.

With these two weighty problems hanging in the balance, it is clear that Venus presents to us at present a far greater interest than any other planet. The study of it is ten times more important than Mars, on which we bestow so much attention, and not even the rare visit of Halley's comet is likely to give us permanent data to be compared with a really reliable determination of the rotation period of Venus.

It is the more remarkable that so little attention has been given to Venus because it is easily within reach of a very moderate-sized telescope. Probably most observers have considered the study of the planet a hopeless one, but this certainly is not the case. Nothing but diligence and good atmospheric conditions are required to give data of the greatest value, and they are likely to be gathered by some one who seizes the opportunity at the present inferior conjunction of Venus.

We give below a discussion of the periods found by several observers since the time of Cassini in 1667, but will first point out the objections to a period of about one day as stated by several writers. The objections rest on the close agreement of the Cytherean day with our terrestrial day and the possibility of periodic deception; but those advancing such views evidently have never examined the original records of Schroeter ([illegible]) and are unaware of the fact that the phenomena of the indentation of the southern horn, to which he gave so much attention, scarcely admits of an interpretation based on mere optical illusion. The indentation of the southern horn is very plain under good conditions, and no division of opinion is possible among experienced observers, for I have myself observed this indentation very plainly with the [illegible]-inch refractor at Washington, and made a drawing of it almost identical with those given by Schroeter in the Philosophical Transactions of the Royal Society for 1[illegible].

In one of his records Schroeter states (Philosophical Transactions, 1[illegible]9[illegible], pp. 117-1[illegible]6) that he saw the indentation plainly disappear after about eleven minutes, and from records made on two successive days found that the Cytherean day is about forty minutes shorter than the terrestrial.

In making the second observation on the indentation of the horn, February 27th, 1[illegible]93, he was unaware of the time recorded on the previous day, and thus all bias or prepossession of mind was avoided.

It must be admitted that a day of 2[illegible] hours 21 minutes for Venus cannot easily be explained by a deception. For why should the different observers all reach about the same result, giving a day [illegible] minutes shorter than our terrestrial day, instead of a day of almost exactly 24 hours? Evidently no good reason can be assigned for assuming that experienced planetary observers such as Schroeter were deceived.

If, on the other hand, we turn to the modern spectroscopic observations, we find them in conflict among themselves. Belopolski found indications of a period slightly shorter than a day (A. N. [illegible]641), while Lowell and Slipher, repeating the observations, got no indications of a rapid rotation (A. N. 3891). Schiaparelli's visual observations (A. N. 3301) are not as conclusive as one might wish, and Lowell came to reject his early maps of Venus as illusory (A. N. 3823). The only clear evidence that we have therefore is the early observations of Schroeter, which are remarkably convincing, and the later observations of DeVico, which confirm Schroeter's work in every respect. Schroeter found the time of rotation to be 2[illegible] hours 21 minutes [illegible]1 seconds, and DeVico changed this period by less than a second, his final result being 23 hours 21 minutes 21.934 seconds.

Finally, it may be added that I have detected a theoretical cause which would tend to make the rotation of Venus more rapid than that of the earth, while that of Mars would be slower; but it is not advisable to go into that at present, and we content ourselves with discussing the old observations and pointing out a piece of work within the reach of an industrious amateur.

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* Popular Astronomy.

DEEP-SEA LIFE.

STRANGE INSTANCES OF ADAPTATION TO ENVIRONMENT.

BY GLADYS GRAHAM MURRAY.

Naturalists of olden days were of the opinion that there was an absence of life in the deep seas. Today this theory is known to be incorrect, and the fact that a deep-sea fauna exists is familiar to every zoologist.

The relationship between animals and their environment is a subject which deserves close attention, for little by little animals modify themselves to the conditions under which they live. It is therefore interesting to consider the physical conditions of the mighty deep. To these enormous depths no sunlight can penetrate, for it has been reckoned that after a depth of five hundred fathoms (three thousand feet) the sun's rays will be unable to pierce their way. Such illumination as exists in very deep waters is doubtless due to the fact that many deep-sea fish possess phosphorescent organs.

The late Sir Wyville Thomson wrote that after he left Cape Verde Islands the sea was a blaze of phosphorescence. There was no moon, and although the night was perfectly clear, the luster of the heavens was fairly eclipsed by that of the sea. It was easy to read the smallest print sitting at the after-port in my cabin, and the bows shed on either side rapidly widening wedges of radiance, so vivid as to throw the sails and rigging into distinct lights and shadows.

If phosphorescence such as this exists at great depths, it accounts for the well-developed eyes and brilliant colors of some of the deep-sea animals; on the other hand, a large proportion of the denizens of the deep possess either no eyes or eyes reduced to mere vestiges.

At great depths there is no movement of the water, no tides are felt and no gales blow to ruffle the bottom of the abyss. Owing to the absence of sunlight, plant life ceases to exist, and a vast silence must reign perpetually. It is difficult to realize the immense pressure of such deeps, for at a depth of over two thousand five hundred fathoms (fifteen thousand three hundred feet) the pressure per square inch is two and a half tons, whereas on land the pressure exerted is under fifteen pounds per square inch. Should the fish therefore inhabiting these depths get carried upward to the surface, the swimming bladder becomes greatly expanded, and when they reach daylight generally bursts.

It is interesting to consider the question of the temperature of the sea. Deep water is always very cold, but owing to the influence of polar currents the temperature for a given depth may not be the same. Research has shown that in the Atlantic Ocean there is a strong predominance of the Antarctic polar current.

The carpet of the deep sea is composed of different muds and ooze. Globigerina ooze is that which is chiefly composed of the shells of that minute animal life, the *foraminifera*. It is found at depths ranging from five hundred to nearly three thousand fathoms in equatorial and temperate latitudes, but not in Arctic seas. Ninety-five per cent of this ooze is made up of carbonate of lime.

The commonest of sea deposits is that known as red mud. This is said to exist over one third of the earth's surface. The shells of the different animals are acted upon by the free carbonic acid which sea water contains, and they are quickly ground down by this powerful solvent. Another ooze is radiolarian ooze, in which almost no trace of carbonate of lime is found; this occurs in the deepest waters of the central and western Pacific Ocean, while in the deep water near the Antarctic circle a diatom ooze is found.

Zoologists of today make a special study of the geographical distribution of terrestrial animals, mapping out the world into different regions and sub-regions, but there is always some debatable ground, for Nature has no set limits, and one fauna will gradually merge into another. In the sea no mountain ranges or great deserts act as barriers; consequently the fauna of the ocean varies according to the temperature, pressure, the amount of light, the salinity of the water and the food supply.

Three great primary zones are recognized. These are the Pelagic, the Neritic and the Abysmal zones. The Pelagic zone includes the superficial waters of all seas, while the Neritic (or shallow water zone) embraces all depths less than five hundred fathoms, including inland seas, shores of great continents and isles and shallow banks in the great oceans. The last well-marked zone is the Abysmal, which extends from the [illegible]00-fathom line to the greatest depths of the ocean.

It is interesting to consider the views which are advanced by naturalists as to the origin of the mighty abysmal fauna, and the question arises as to whether the curious creatures that live at such mighty depths—many of them in total darkness—are the remnants of the fauna of shallow prehistoric seas or are the progenitors of the shallow water population. The explanation which is generally accepted, and which was put forward by the late Prof. Moseley, is that the fauna of the deep sea has been derived from successive immigrations of the animals inhabiting the shallow water, and this theory is greatly strengthened by the fact that as a rule the deep-sea fauna is much richer in the neighborhood of land than in regions far from it.

Marine animals pursue three great modes of life. There are those—such as the jelly fish or medusae—which float and drift with the currents of the sea and are scarcely able to determine for themselves the direction in which they travel. This portion of the ocean's fauna is called the *plankton*, while the *nekton* are those animals which are capable of vigorous swimming movements and are able to migrate freely from one part of the sea to another. Lastly, there are those animals which remain as fixtures or are only capable of crawling over the rocks or sand, and to this group the name of the *benthos* has been given.

It is interesting to look at the colors of the skin of the different deep-sea animals, which vary to a remarkable extent in the separate groups—some brilliant colors being found in certain cases and in others a somber hue predominating. Among the mollusca violet is the prevailing color, and in a specimen brought home by the "Challenger" expedition a rose-colored denizen of the deep was reported. Various shades of red seem to prevail among the crustacea, while the large eggs of some of the deep-sea genera were of a brilliant light blue. This latter color is very rarely met with in the fauna of the abyss. To turn to the deep-sea jelly fishes, deep violet or a yellowish red hue is said to predominate, while Agassiz reported a particular species as being remarkable for the light carmine tint. In speaking of corals and deep-sea anemones, the same author recorded that 'some deep corals were scarlet, deep flesh colored, and pinkish orange.'

The eyes of the deep-sea inhabitants have undergone some curious modifications. In the majority of cases it is usually found that the eyes are either very large or very small. A species of fish dredged up from a depth of over one thousand two hundred feet by the Porcupine expedition possessed a pair of well-developed eyes on short footstalks. In some cases the loss of sight is greatly compensated by the high development of the tactile organs, which probably possess a very delicate sense of touch.

Many deep-sea animals have the power of emitting phosphorescent light, some possessing distinct organs for this purpose. Certain sharks secrete a highly phosphorescent slime in their skin glands, whilst other deep-sea fish display curious eye-like organs down the sides of the body, forming, as it were, a series of miniature bull's-eye lanterns. Again others possess glandular organs behind the eyes or on the head and shoulders.—Chambers's Journal.

SCIENTIFIC FACTS ABOUT EGGS.

THEIR CHARACTER, SELECTION, HANDLING.

THE rules for telling eggs with the candle from now on are as follows:

Forty-eight hours.—By this time the opaque white membrane which surrounds the germ has spread well over the top of the yolk, and the egg is quite dark or heavy before the light. Blood appears at about this period, but is difficult of detection with the candle unless the germ dies and the blood ring sticks to the membrane of the egg.

Three days.—The candle shows changes in this egg that are apparent even to a novice. An experienced candler will have no difficulty in seeing the blood ring through the shell. When broken the blood ring is the prominent feature and is as large as a nickel. The yolk behind the membrane has become watery.

Four days.—The body of the chick becomes visible to the candler and the prominent radiating blood vessels are seen. Upon breaking the yolk is found to be half covered with the sac containing water.

The developments given above occur at a temperature of 103 deg. F. As the temperature is lowered the rate of chick development is retarded, but at any temperature above 70 deg. chick development will proceed far enough to cause serious injury to the quality of the eggs.

For commercial uses the customary grouping of eggs in regard to heating is:

1. No heat shown. Cannot be told at the candle from fresh eggs.
2. Light floats. First grade that can be separated by handling, corresponding to about eighteen to twenty-four hours' incubation.
3. Heavy floats. This group has no distinction from the preceding except an exaggeration of the same features. These eggs are objectionable to the fastidious housewife because of the white and scummy appearance of the yolk.
4. Blood rings. Eggs in which blood has developed, extending to the period when the chick becomes visible.

Chicks visible to the candle.

The loss to the egg trade due to heated eggs is probably greater than that from any other source.

The Texas egg business is virtually dead from June 15th to the fall. The heat ruins the product and kills the profit. That is generally true over the South. The Southerner eats few eggs in the summer.

The egg shell is porous. This is contrary to common experience. The developing chick needs air. Warm temperature and dry air striking eggs cause evaporation and produce the grade called shrunken eggs. Rough handling of shrunken eggs causes a rupture of the inner membrane. This allows the outer air coming through the porous shell to get into the contents of the egg. Thus is produced the watery or frothy egg. This does not hurt the edible value of the egg, but it gives it a bad trade name.

White strength is simply the stiffness of the egg white. Age and mechanical disturbance weaken the network of fibrous material as in shrunken eggs. These eggs will not stand up well or whip into a firm froth. The yolk weakens and breaks. The food value of the egg is not affected thereby. It simply looks bad, spoils for poaching and whipping.

Farmers and grocers hold eggs so long in the summer for better prices that fresh eggs direct from the farm from August to December are the exception. They come direct but are far from fresh. They are not held in cold storage. Most of these are classed as shrunken eggs. They are so well understood as to be left to become a drug on the market.

The egg when laid is virtually germ free. Seldom has it any bacteria. The egg shell is sufficiently porous to admit germs after the egg has been dropped. The fiber-crisscrossed membrane within is germ proof when kept dry. Eggs may be affected by moisture in many ways, when the egg-rotting bacteria may be deposited and enter. The following are the chief classes of egg-rotting bacteria:

1. Black Rots. It is probable that many different species of bacteria cause this form of rotten egg. The prominent feature is the formation of hydrogen sulphide gas, which blackens the contents of the egg, giving the characteristic rotten egg smell and sometimes causing the equally well-known explosion.
2. Sour Eggs or White Rots. These eggs have a characteristic sour smell. The contents become watery, the yolk and the white mixed, and the whole egg offensive to both eye and nose.
3. The Spot Rot. In this case the bacterial growth has not contaminated the entire egg, but has remained near the point of entrance. Such eggs are readily picked out with the candle, and when broken show lumpy adhesions on the inside of the shell. These lumps are of various colors and appearances. It is probable that spot rots are caused as much by mold as by bacteria, but for practical purposes the distinction is immaterial. The responsibility for decayed eggs is chiefly with the farmer.

There are moldy eggs caused by wetting the cases, damp cellars or the sweat of iceboxes. These usually are afflicted with the spot rot. The musty egg is free from organisms.

Eggs should never be stored in musty cellars or in rooms with citrus fruits, vegetables, fish or cheese. The egg takes on the odors of those products and prejudices the fancy trade.

The following is a summary of the approximate losses to the egg trade due to detrimental changes: Dirties, 2 per cent; breakage, 2 per cent; chick development, 5 per cent; shrunken or held eggs, 5 per cent; rotten eggs, 2½ per cent; moldy eggs, ½ per cent. In all 17 per cent.

Eggs are naturally worth more intrinsically when laid than when they reach the consumer. If marketed as laid the eater of low grade eggs would eat real fresh eggs but pay a higher price for them. This would probably force him to substitute other food for his egg diet.

The American egg crop is gathered and marketed about as follows:

The eggs are gathered by the farmer with varying regularity and are taken perhaps on the average of once a week to the local village merchant. This merchant receives weekly quotations from a number of surrounding egg buyers, and at intervals of from two days to two weeks ships his eggs by local freight to such dealers. The dealer buys the eggs case count, that is, he pays for them by the case, regardless of the quality. He usually repacks the eggs in new cases and may or may not candle them.

This dealer in turn receives quotations from city egg houses and sells the eggs by wire. He usually ships in carload lots. The city receiver may also be a jobber who sells to grocers, or he may sell the carload outright to a jobbing house. The jobber recandles the eggs, sorting them into a number of grades, which are sold to various classes of trade.

The loss in candling is generally kept account of, but is seldom charged back to the shipper.

By "loss off" or "rots out" is meant the subtraction of the bad eggs from the number to be paid.

The jobber grades the eggs as the trade demands. In New York there are as many as seven or eight grades. The finest are packed in sealed cartons. The first class hotels, clubs, restaurants and soda fountains buy the strictly high grade eggs. The elements of cost for a dozen eggs purchased in New York for [illegible] cents run about as follows: Paid the farmer [illegible] cents; profit to shipper ½ cent; freight to New York 1½ cent; gross profit of receiver ½ cent; gross profit of jobber 1¼ cent; loss from candling 2 cents; gross profit of retailer 4 cents. Total, [illegible] cents. Any increase along the cost line increases price to consumer.

Bakeries and low class restaurants take the cheapest grade of eggs.

Boards of health have difficulty in preventing the sale and use of "spot rots" and low grade eggs. The dead line between dead chick and other low grade bacteria contaminated eggs cannot be well defined. The buyer must use his judgment.

The fact remains that farmers' eggs, whether shipped direct to the consumer or to the merchant, may not be fresh in any sense. They may have lain in the sun or other heat days after having been laid, or may have been kept under unfavorable conditions until enough were gathered for the market. The indifferent results obtained in making dressings and other dishes where eggs form an important item is often due to the use of eggs laboring under some affliction that does not disqualify them in any sense as a wholesome food. The pastry or other cook will avoid much trouble on this score by a careful study and examination of the character of his egg component before using it. The jobber simply grades the eggs as the trade demands. A reliable jobber who knows the uses to which his customer wishes to put the eggs bought is a valuable man to aid the steward or other buyer in the selection of the stock for his purposes. If the customer is not an expert at all the stages the capable merchant should be cultivated, as he grades to suit the case and becomes a great and needed help in the proper selection of eggs for needs of the consumer.—Spatula.

RECENT PROGRESS IN ELECTRICAL ENGINEERING

DR. KAPP, the president of the Institution of Electrical Engineers, in his inaugural address passed in review the industrial progress that had been made in electrical engineering during the last ten years and pointed out the changes that had been made in the design of electrical apparatus. The modern practice is to use very large generators and to drive them by turbines. The manufacturers are prepared to build machines, which have an output of more than 20,000 horse-power, and generate electricity at 15,000 volts. These large machines are particularly useful in the electro-chemical industries, especially those for 'fixing' atmospheric hydrogen with the object of producing a fertilizer to replace Chili saltpeter. Electric arc furnaces are used by the Norwegian Nitrogen Company, and their yearly output is 20,000 tons of nitrate of lime. By 1911 it is expected that the production will have increased to 100,000 tons. The process is entirely electrical. No fuel of any kind is used. The heat required for steam raising and other purposes is obtained as a waste product from the electrical furnaces. Dr. Kapp gave some interesting particulars of the applications of electricity to stimulate the growth of plants. Until Sir Oliver Lodge took up the problem of utilizing Lemström's discovery that the electrification of the atmosphere immediately above growing crops had very appreciable effects both on the height to which they grew and the weight of the ears produced, very little progress had been made. In Lodge's arrangement a network of galvanized iron wires is stretched over the field to be treated and is suspended at a height of 18 feet from the ground by means of wooden poles with oil insulators. About one post per acre is required. The network is positively electrified to between 60,000 and 100,000 volts by means of an induction coil and a dynamo driven by a small hot-air engine. The power required is very small, but under the treatment the increase in the yield per acre is about 30 per cent. The system is in use on several farms in this country, and on six in Germany, so convincing data should soon be available. In conclusion Dr. Kapp pointed out how the introduction of electricity into our great industries could be accelerated by reading papers at the local sections which would be of interest to the particular industries in the neighborhood.

Waterproof Paint for Brick Walls.—This consists of two consecutive coatings, of which one is composed of soap and water (1,000 parts water to [illegible] parts soap) and the other of alum and water (20 parts alum to 1,000 parts water). The wall must be perfectly dry and clean, the temperature of the atmosphere not higher than 50 deg. F. The soap coat is first applied with a brush in a boiling hot condition. It dries in 24 hours and hardens; then comes the alum coating at a temperature of 60 to 70 deg. F. After 24 hours the entire process is repeated, and this is done until the wall becomes impermeable to water. The number of applications necessary is governed by the pressure of water to which the wall is exposed.

ENGINEERING NOTES.

An air steam engine has been invented by a professor of engineering in one of the Western colleges of this country In this invention a cylinder is filled with compressed atmospheric air into which saturated steam is introduced The chief merit claimed for this system is that cylinder condensation is almost totally avoided by the high temperature of air compression and the high superheat of the mixture

The Ganz steam motor car built by the Railway Auto Car Company and tested by the Chicago, Rock Island and Pacific Railroad about a year ago has been returned to the railroad fitted with a new Ganz engine of low steam pressure and a new Baldwin boiler and superheater The car will shortly be placed in service on one of the company's branch lines

It is sometimes difficult when necessary to use a car jack on unpaved sections of the line to find a firm foundation upon which to work To avoid trouble from this condition, the motormen of the Grosse Berliner Street Railways have been advised to take a motor trap-door from the car for a jack base The men are also provided with small wooden blocks to keep the door in a horizontal plane where the roadway is very uneven

Heavy explosions in the sewers of a portion of New York city containing many garages, states a contemporary again draw attention to the danger of allowing petrol to enter sewers Some of these explosions were so violent as to resemble the explosion of a small boiler Manhole covers were blown into the air windows in the neighborhood were shattered, and a number of persons injured The sewers of the city discharge into tide water, and at high tide the sewage in them backs up in some cases. It is probable that petrol floated on the surface of the sewage when the latter was backed up by high tide, and its vapor was ignited by a spark that might have been due to several causes While such explosions will not follow every discharge of petrol into sewers, their occasional occurrence and the possibility of much serious injury from them states our contemporary, are a justification for rigid rules efficiently enforced to prevent the practice

The bond between concrete and steel as influenced by repeated loading has been investigated by Prof B Kirsch of Vienna, and a summary of the work was presented to the Copenhagen Congress of the International Association for Testing Materials The bars were plain 20 mm square some rusty and some bright, and were tested by embedding one end in a 1 3 Portland cement mortar cube of 20 cm edge The adhesion surface was 125 square centimeters, and the load applied was 150 kilos, amounting to 1 2 kilos per square centimeter, or 17 pounds per square inch of bonding surface The load was applied fifty times, this limit being set because Prof Kirsch believes that any loosening of the bar, if noticeable would become apparent after a few applications The experiments on specimens one month and three months old convinced Prof Kirsch that a repeated load of 17 pounds per square inch does not produce any alteration in the adhesion either with bright or rusty bars The cubes, on the completion of the adhesion experiments, were tested in compression, the rods being left in them, and developed strengths of 1 520 pounds and 1,790 pounds per square inch for the one-month and three-month cubes respectively

A coal dust experiment gallery near Sebengottes, Austria, is described in the Iron and Coal Trades Review Experiments are still in progress at this gallery under the auspices of the Vienna committee on fire damp with the object of determining conditions under which coal dust is likely to explode The gallery, which is 961 feet long is constructed of masonry and is buried under from 6½ to 70 feet of earth, the depth of earth covering decreasing as the distance from the explosion chamber increases The explosion chamber is of concrete, 6 feet high 6½ feet long, and 4¼ feet wide. The arched roof of the gallery is 6¾ feet above the floor at the end nearest the chamber and its height increases to 7¾ feet at the farther end The gallery is equipped with sloping wooden ledges for coal dust and with apparatus used in investigations of the efficacy of preventive measures such as wet zones, water sprays, and zones of stone dust. The length of flame produced by the explosion is measured by means of sulphur matches placed along inside the gallery at intervals of 40 inches Samples of the fumes produced by the explosion are obtained by means of loosely corked bottles of water suspended bottom up in the gallery 33 feet from the explosion chamber Strings attached to the corks are fastened to the nearest rack of shelves which are hung at intervals in the gallery to hold coal dust The movement of the shelf racks due to the explosion draws the corks and the water runs from the bottles and is replaced by gas The samples thus obtained are found to contain 0.8 per cent to 6 45 per cent carbon dioxide, 0.3 per cent to 8 2 per cent carbon monoxide and 10 95 per cent to 18 3 per cent oxygen —Engineering News.

ELECTRICAL NOTES.

Steam and electric traction on the same tracks has been in operation on the Colorado and Southern Railway for about 26 miles out of Denver, Colo, since May, 1908 No difficulty has been experienced in the operation of trains, and it has not been found that smoke or steam has in any way damaged the overhead construction The electric cars operate a suburban and interurban service auxiliary to the steam train service.

The Marmier and Abraham process of sterilizing water by ozone from electric apparatus was one of the best in the recent concourse held by the city of Paris, and the cost of sterilizing a cubic meter of water was the lowest The test was made upon a current of 300 cubic meters of water per hour, and the electric current cost 0 055 franc per kilowatt-hour, with labor 1.40 francs per hour (two attendants). The figures for the total expenses, including interest and depreciation, show that a cubic meter can be sterilized by the process for 0 0098 franc, or about 0 2 cent.

It is proposed to erect an electric generating plant on the Colorado River at what is known as the Needles, situated about 25 miles south of Powell, Ariz Col C E Apponi has secured the water rights to a strip of the river territory five miles in length at the first rapids and it is at that place the plant will be situated A complete survey of the site has been made, and a syndicate of Milwaukee has been interested The initial plant will have a capacity of 30,000 horse-power, and a number of transmission lines to supply towns and industrial plants within a radius of 170 miles of the generating plant will be erected There are also many mines within the proposed radius A large dam will be constructed, a storage reservoir will be built, and a system of canals will be utilized for irrigation purposes over a large area of land The estimated expenditure is about $200,000

Among the electrical exhibits at the Brescia Exhibition, states the Electrician is a complete installation of the Bellini Tosi system of directive wireless telegraphy Owing to the confined space—for the exhibition i held in part of the Castle of Brescia the transmitting and receiving stations are only 40 m apart; but, with the exception that the antennæ employed are reduced to only 3 m in height, all the other apparatus is of full size—in fact, the radio goniometer at the receiving station is the actual apparatus which is to be erected in the new station of the French government (post office) which will shortly be opened at Boulogne All the special features of the system, such as directive emission and reception of the waves and location of the direction of the transmitter, can be readily demonstrated, in spite of the small distance between the stations

The Electrical Review and Western Electrician gives an account of an electrically-driven rail bender in which the framework of the machine is a heavy steel casting made in one piece, the solidity of which insures regularity of curvature and rapidity of work, which, with the small amount of manual labor required, renders the tool extremely useful on construction work The power-driven bending roll is mounted in a frame which is driven forward to give the desired curvature by a hydraulic cylinder, the power for which is a small hand pump mounted on the frame of the tool above the cylinder The roll can be driven out under a pressure of 50 tons The two fixed roll centers are 34 inches apart. The driving roll is geared to make one turn to eight turns of the pulleys, which are 24 inches in diameter and have a 7 inch face The bending rolls are changed by loosening set screws and pulling out the pins. The arm holding the middle bending roll can be worked in and out by a lever without the aid of the pump, if the release valve is open, so that the pump is necessary only when bending a rail to get the desired curvature. The capacity of the machine is about one medium length rail per minute when once adjusted.

According to a contemporary, Prof. Fessenden has proposed to the United States Navy Department the building of a turbo-electric vessel, wherein a steam turbine alternator would drive the propellers through induction motors, but so far the proposition has not been accepted The claim is that there would be a great saving in weight, as the turbine could be operated at an efficiently high speed and so be made much smaller than when designed to be directly connected to the propellers. The same object, states our contemporary, will probably be more economically accomplished by the marine turbine reducing gear patented jointly by Rear Admiral George W. Melville, U. S N., retired, formerly chief engineer of the United States navy, and Mr. John H. McAlpine, who was also formerly in the navy. The first model of this gear was recently completed at East Pittsburg, Pa. It consists of a floating frame supporting two spiral gears. Each has a 22 inch face; the smaller, of 14 inches pitch diameter, is connected to the turbine shaft, while the larger, of 70 inches pitch diameter, is connected to the propeller shaft. The tensile strength of the steel used is 90,000 pounds per square inch, and it is expected that the gear will transmit 6,000 horse-power. It is suggested that it will greatly reduce the weight and cost of transatlantic steamship and battleship power plants.

TRADE NOTES AND FORMULÆ.

Paint for Iron Ships.—600 parts of asphalt or black pitch, mixed warm with 480 parts of boiled linseed oil; to this add a mixture of 600 parts of graphite, 120 parts of arsenate of copper, 640 parts of refined oil of coal tar To be applied hot.

Waterproof Paint for Stone.—Equal parts of palmitate of alumina and rosin are melted together, or palmitate of alumina and wax mixed, and this mixture dissolved in caustic soda lye and water. After application and drying, rinse off with a weak solution of sulphate of alumina in water.

Paint for the Mortar of Brick Walls.—84 parts of fine drifting sand, 12 parts of unslaked lime and 4 parts of skim milk cheese that has been pressed through a wire sieve. These substances are to be first well mixed dry, then with a sufficient quantity of hot, not boiling, water, prepared for application. It must be quickly applied.

Paint for Metals.—10 parts of finest powdered stick sulphur is dissolved, with the application of heat, in 90 parts of oil of turpentine and mixed with 50 parts of linseed oil varnish. This very firmly adhering paint can be colored black by the addition of lampblack, brownish red by the addition of English red, and white by means of zinc white.

Waterproof Paint, according to Hafen.—Boil 7,500 parts of linseed oil with 331 parts of rosin, 330 parts of litharge, 50 parts red lead, and 50 parts umber; gradually add 230 parts of zinc vitriol and a solution of 350 parts caustic potash, 350 parts of alum, 15,000 parts of chalk, 1,000 parts of zinc white, with 3,000 parts of water, in which 40 parts of alum have been boiled; then add a decoction of 750 parts of glue with 2,000 parts of water. The paint is mixed with 2,000 to 2 500 parts of varnish, and the mixture thinned with petroleum.

Protective Against Moths.—Carbolic acid is recommended for use in fighting moths. For cloth storage use the following mixture 45 parts pure carbolic acid, 30 parts camphor, 30 parts oil of rosemary, 5 parts oil of cloves, and 5 parts of aniline dissolved in 2,500 parts of alcohol For furriers, 20 parts pure carbolic acid, 10 parts oil of cloves, 10 parts oil of lemon peel, 10 parts nitro-benzole, 2½ parts aniline dissolved in 1,500 parts of pure alcohol. With this fluid the goods are moderately sprayed with the help of an atomizer. If they are kept in tight packages, one spraying will suffice for the season Cloths in storerooms will require twice spraying Another very effective method of making cloth and other fabrics waterproof, and, at the same time, preventing their destruction by moths, is 10 parts of alum and 10 parts of sugar of lead, dissolved in the necessary quantity of water, are mixed together and the mixture allowed to remain undisturbed until the precipitate of sulphate of lead has settled The clear fluid, which will now contain acetate of alumina, is poured off and mixed with a large quantity of water, in which dissolved isinglass has been stirred. The objects to be protected are immersed in this mixture and left in it for 12 hours, until they are saturated, after which they are allowed to dry and finished by pressing or some other method. Fabrics made waterproof in this manner are not attacked by insects. Another means of protection from ravages by moths (for upholstered goods) is the following. Horse hair, such as is used for upholstering, must be colored yellow by picric acid (30 parts picric acid to 10,000 to 12,000 parts of water). As the picric acid is not volatile and is not scattered, if furniture, upholstered with hair colored yellow by picric acid, is beaten, no injury to human beings is to be apprehended, while the protection against moths is absolute.

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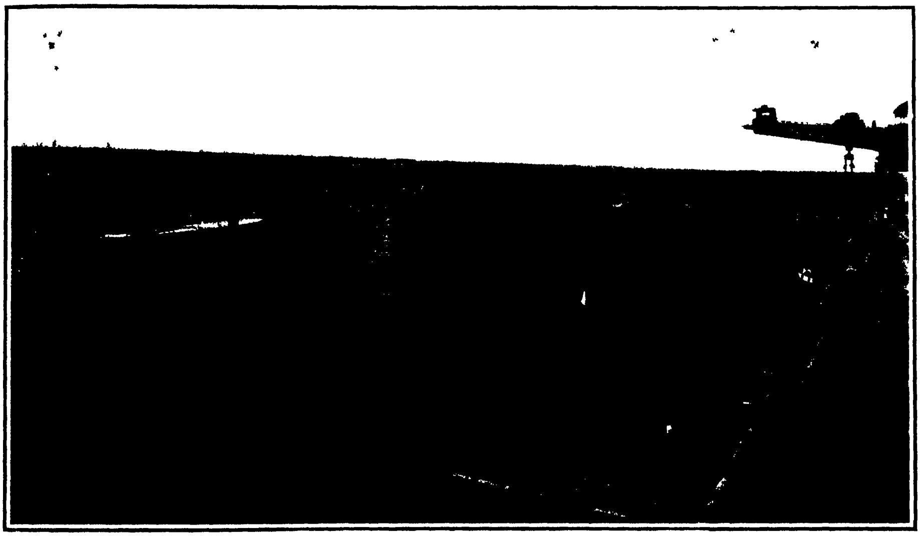
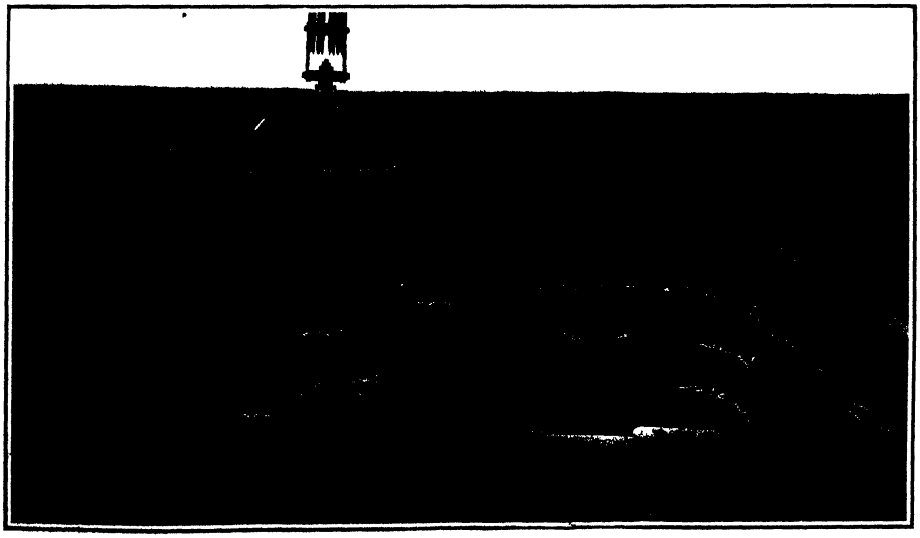


THE CAISSON READY FOR LOADING TO A DRAFT OF 27 FEET



FILLING THE CAISSON WITH CONCRETE BLOCKS AT THE PIERHEAD

THE MADRAS HARBOR WORKS SINKING THE PIERHEAD CAISSON

THE MADRAS HARBOR WORKS.

SINKING THE PIERHEAD CAISSON.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Some years ago the deplorable facilities at Madras harbor were such as to cause shipping to avoid the port as much as possible When finally a new board was organized the chairman Mr F J E Spring C I E resolved upon a comprehensive improvement scheme which has been in progress for some years past and is now nearing completion The work included the erection of a north breakwater arm [illegible] feet long to protect a new entrance This arm is very exposed and the constructional operations in connection with the pierhead involved the difficult task of erecting and setting into position a large iron caisson

This structure is of square design with sides 12 feet in length by [illegible] feet in height the corners being rounded It is built up of a horizontal and vertical framework of [illegible] inch by [illegible] inch by ⅝ inch angle iron the shell comprising ¼ inch plating Complete it weighs 110 tons Such a design has obvious disadvantages which render its setting a difficult matter inasmuch as a caisson with flat sides is not so capable as the circular form of resisting such a considerable head of water as is here experienced Consequently the work necessitated unremitting care and skill

The structure was built up on the slipway When riveted up to a height of [illegible]3 feet it was successfully launched The caisson was then towed and moored alongside a wharf where the remaining 8 feet of its height was completed the structure being turned round so that one side at a time could be easily handled While this part of the work was in progress a bed of concrete was laid over its bottom [illegible] inches in thickness and following the contour of all the sides in the shape of a wall 12 inches thick When the shell was completed and the flooring finished the structure drew 6 feet of water and displaced [illegible] tons At this juncture the caisson was towed to a convenient point near the pierhead so as to come within range of the [illegible]0 ton titan crane used in the breakwater constructional work Here more concrete was added until the caisson drew 27 feet of water It was then ready to be set into position

This part of the work offered many perplexing problems The crucial question was how to dispose the concrete within the caisson so as to sink it to a depth of 27 feet in the water in such a way that the fragile sides might secure the maximum of stiffening with the minimum of concrete Had the concrete been spread in a mass on the bottom 11 feet of it would have been sufficient to sink the structure to the requisite [illegible] feet In this case there would have been left 16 feet of thin metal shell with no support whatever against the head of water that would have been brought to bear upon it The question was adroitly solved however The interior of the caisson was divided into a number of compartments by the construction of two pairs of cross walls extending at right angles to one another the thickness diminishing toward the top In this manner the same quantity of concrete which would have given a solid mass 11 feet in thickness to sink the caisson to 27 feet draught was so distributed as to reach to a height of 26 feet from the bottom Hence the sides were adequately strengthened

While this work was in progress the preparation of the foundations for the caisson at the pierhead was undertaken A rubble bed measuring 47 feet each way and 11 feet deep had been completed and its top surface carefully leveled by divers When this was completed four 15 inch vertical timbers were strutted back to the end of the masonry work to serve as a guide face in setting the caisson

When the caisson was sunk to a depth of 27 feet its displacement was 1[illegible]0 tons The towing of the structure to the site was a delicate task As calm a day as possible was selected for the operation This was successfully accomplished Elaborate precautions had been adopted to hold the caisson firmly in position while the final settling was in progress For this purpose two 100 ton lighters were moored about 200 feet on either side and chains passing around winches on the lighters decks served to hold it firmly *in situ* or to shift the caisson one way or the other as desired In order to control the movement up to the vertical timbers ropes were passed around the caisson and through tackle to the winches of the port 1 000 ton dredger By pulling on these ropes the caisson was tightly jammed against the vertical guide timbers Any displacement in any direction could thus have been easily and quickly readjusted

When all was ready water was admitted into the caisson to sink it on the site The structure rapidly settled down on the prepared bed Directly this was accomplished the titan crane temporarily loaded the structure with 2[illegible] solid masonry blocks weighing some [illegible]00 tons to prevent any shifting

Setting completed the port dredger was brought alongside and assisted in pumping out the water to within a depth of 12 feet of the bottom The filling in with concrete and masonry blocks was then pushed forward rapidly The concrete blocks inserted temporarily were withdrawn from one compartment at a time and then properly built in and strutted to each other and to the sides of the caisson this task together with grouting being continued until the whole structure had been filled to the top of the strutting girders which were then built into the concrete In this manner a depth of 21 feet from the bottom of the caisson was completed For the succeeding 12 feet of height blocks measuring 11 feet long by 6 feet wide and deep respectively and 10 feet long by 6 feet wide and deep respectively were built in alternately to break the bond all being bedded in mortar and filled around with 6 to 1 concrete The skin of the caisson and the side walls was strutted to the blocks as the concrete was continued upward the opposite faces of the caisson being clamped together at the level of 36 feet above the bottom by chains and unions which were subsequently built into the structure When the 36 foot level was gained the surface was leveled off so as to form a bed for the granite faced blocks forming the pierhead above the water level

After being sunk the filling of the caisson to the 36 foot level occupied seventeen days in which period [illegible]713 tons of concrete was built into the structure giving a net weight resting upon the foundations of 2138 tons When the superstructure is completed the weight will aggregate 3 800 tons The completion of these improvements will provide the port of Madras with one of the most up to date harbors in India

PRODUCER-GAS FOR ENGINE FUEL.*

CONDITIONS TO BE MET WITH THE VARIOUS FUELS USED.

BY E. A. ALLCUT

During the last few years the application of gas power for engine work has been rapidly extending The increase in the use of gas for the purpose of power generation has been as noticeable in the smaller units of 100 horse power and under as in the larger installations This continued demand for small units is all the more striking when we consider the favorable rates at which electrical energy is available for power purposes in most of the English towns It would seem at first sight a hopeless undertaking for the small power user to generate his own supply in face of such formidable competition The success of the gas driven plant under such adverse conditions is due to improvements in the gas producer rather than to the adoption of any new principles in the engine itself

In all industrial companies cheap power is an important desideratum The demand of the majority of manufacturers is comparatively low and as steam-driven units of small size are rather uneconomical the choice usually lies between electricity or gas from the public supply and private generation from a gas producer The first two are usually only available at cheap rates in large towns while the tendency is for manufacturers to remove their works to districts a few miles away where land is cheap and taxes are low Above 500 horse power however the steam engine begins to be a serious competitor to the gas engine as with high powers its efficiency is greatly increased and the difference between it and the gas engine is by no means so marked as in the smaller units The use of large producer gas plants appears nevertheless to be gaining ground though in view of these and other considerations more slowly than that of the smaller types Gas engines of large size 1 000 horse power and over have not up to the present been successfully worked on producer gas The large reciprocating weights in the standard double acting engine together with the tarry matter present in the gas present great difficulties which practically preclude its use with a rich gas These difficulties may be overcome in the future but for the present the large gas engine has only a limited application There is however a useful sphere of service open to it in connection with the blast furnaces of our iron districts The poor gas of 70 to 100 B t u per cubic foot given off from the furnaces can be and is very often used in these large engines both for producing the necessary blast for the furnaces and for providing light and power to the works and surrounding district This in itself forms a huge source of economy and will no doubt, in the future be universally applied

We now come to a consideration of the gas itself Producer gas is understood technically to mean the gas generated by the partial combustion of carbon or carbonaceous matter in a closed chamber called a 'gas producer In practice, the carbon is supplied in one of the numerous forms of coal charcoal or coke while for certain purposes lignite or peat may be used The quality of the fuel largely influences both the composition of the gas produced and the design of the producing plant itself When air alone is supplied to the combustible the carbon simply burns to carbon monoxide and parts with some 5800 of its available 14 600 B t u per pound, leaving the other 8,800 B t u bound up in a convenient form for use in the engine cylinder We thus use up 40 per cent of the heat lying dormant in the carbon with the object of storing up the residual 60 per cent in a convenient form for the direct production of mechanical energy This seems at first sight to be a most uneconomical proceeding but the waste of heat in other forms of transforming apparatus is so great as to justify this apparent waste Of course, some of this sensible heat is recovered as we shall see later on The theoretical composition of the gas thus generated is some 35 per cent of carbon monoxide and 65 per cent of nitrogen giving a calorific value of 118 B t u per cubic foot This is the theoretical composition of blast furnace gas The coke present in excessive quantities presents a deep bed of incandescent fuel to the air blast with the result that the furnace becomes a huge gas producer The quality of the gas, as we have seen is poor but it is free from tarry matter and when denuded of its dust forms an admirable fuel for the large double acting engines chiefly met with in continental practice The low explosion pressure given by this gas provides an indicator card very similar to that of the steam engine with a corresponding absence of shock in the moving parts and a more uniform turning effort at the crank than is obtained with engines working on richer gases Smaller producers working on air blast however tend to clinker up, owing to the high temperature, and thus give intermittent working and bad gas To absorb some of the 40 per cent of sensible heat given out by the carbon steam is added to the air on its way to the producer The reaction of steam with incandescent carbon is endothermic and results in the production of equal volumes of carbon monoxide and hydrogen The resulting gas, called water gas, has a thermic value of about 350 B t u per cubic foot The addition of steam therefore has the double effect of reducing the temperature of the producer and enriching the gas produced, the normal calorific value of "semi water gas," or producer gas proper, being about 160

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[*] American Machinist.

B t u per cubic foot when bituminous coal is used as fuel The great question however is How much steam shall we use? The Mond plant uses about 2½ pounds of steam per pound of coal consumed while the blast furnace uses none It is obvious that with excess of steam as well as with no steam at all the conditions are not so favorable for the production of a rich gas as they are at some intermediate stage The combustion of carbon even with a small supply of air, cannot always be limited to the production of carbon monoxide The higher oxide CO_2 is always present in large or small quantities The extent to which the higher oxide is formed is solely a function of the temperature so that the admission of steam in controlling the temperature has a further action upon the chemical composition of the gas produced A temperature of 1 000 degrees Centigrade and over favors the formation of monoxide while at lower temperatures the proportion of carbon dioxide in equilibrium with the monoxide becomes greater and greater as we approach 600 degrees Centigrade below which the action becomes inefficient For a rich gas and high efficiency the producer should therefore be kept as hot as is consistent with successful working and the nonformation of clinker

The formation of carbon dioxide instead of carbon monoxide does not however in itself imply inefficient working as the extra heat liberated by the complete combustion of carbon could theoretically be utilized for the decomposition of steam or to raise steam for the process itself At a low temperature however the bulk of the steam passes unchanged through the producer and is simply condensed in the scrubbers so that the heat thus used would be entirely wasted The experiments of Doctors Bone and Wheeler on a 2 000 horse power Mond plant tend to show that no economy but rather loss attends the introduction of excessive amounts of steam into the plant It was found that the best results were obtained with a feed of some 0 45 pound of steam per pound of coal consumed This was with a large plant using bituminous fuel and regenerative apparatus With a small producer using anthracite pea coal and no regeneration my own results point to a supply of 0 7 pound of steam per pound of coal consumed as the best figure This gave a gas very similar to that usually obtained in a suction plant and indeed, the conditions obtaining during the test were very similar to those under which suction plants work The practice of adding 1 pound and upward of steam to the air blast is therefore wasteful in steam necessitating the erection of a large and costly regenerative plant to recover the latent heat of the unchanged steam and produces a poor gas

The fuels principally used in gas producers are anthracite and bituminous coals The former consisting of 90 to 95 per cent of carbon produces very few volatile hydrocarbons and little ash and is therefore an admirable fuel for this work On the other hand it produces a poor gas and on account of its scarcity in England is very costly The bituminous coals are cheap and abundant and can be used in plants of the largest size It is noteworthy that these producers are designed to use the smallest sizes of coal that were formerly useless for steam raising purposes and to use the very cheapest fuel available The chief objection to the use of bituminous fuel is due to the large quantities of volatile hydrocarbons given off by the coal on heating The presence of these impurities necessitates the use of elaborate cleaning devices to wash out all the tar and dust from the gas before it enters the engine cylinder where these deposits form a prolific source of trouble Even with the present day washers small quantities of tarry matter leak through the apparatus and necessitate the frequent cleaning of valves or else preignition occurs The initial cost and complication of this cleaning plant is sufficient to prohibit the use of bituminous coal in small installations where the cheap fuel would otherwise be very welcome Consequently plants of small size are almost invariably worked with anthracite or coke The latter though cheap contains invariably quantities of ash which tend to fuse into clinker so that its use is by no means so widespread as one would otherwise expect

The design of the producer and plant depends almost entirely on the class of fuel used A non bituminous fuel is free from volatile matter the producers and cleaning plant are very simple in design simply consisting of a firebrick lined shell with a grate supporting a deep bed of fuel and devices for feeding in the fuel and taking out the gas The air is forced in by a steam injector when an auxiliary boiler is provided or if not by a fan Although the plant may be slightly less efficient when the injector is installed yet it is more self contained as the presence of a fan presupposes the existence of an independent prime mover or a separate electric supply The sensible heat of the hot gases which leave the producer at a temperature of some 00 degrees Centigrade are usually extracted by a boiler or regenerator surrounding the outlet pipe on the top of the producer The only cleaning and cooling apparatus necessary is a coke scrubber and a sawdust drier It is obvious that the gas must be cooled to as low a temperature as is economically possible so that the maximum weight of gas and air may be admitted to the engine cylinder The high cost of the fuel forms a serious obstacle to the extended use of this type of plant For some years after the introduction of gas producers the engines used with them were quite small and so it was quite possible to use these high grade fuels But of recent years the gas engine has been developed to give 1 000 to 1 000 horse power in single units and the capacity of the producer has been correspondingly enlarged When large quantities of fuel are daily being converted into combustible gas the price of fuel becomes an important item The utilization of our cheaper grades of coal and even lignite and peat has therefore assumed an important phase

There is nothing new in making gas from bituminous coal this has been done from the first for furnace work where the hydrocarbons present are actually advantageous as they increase the heat of combustion of the gas For engine work however the tar and soot must be effectually cleaned out of the gas and it is here that the chief difficulty lies

The first serious attempt to tackle this problem was made by Dr Ludwig Mond and the details of his famous plant are now well known it is therefore unnecessary to describe it here

It should be remembered however in connection with this part of the subject that bituminous coal contains a fair proportion of nitrogen which under suitable conditions appears in the gas in the form of ammonia On treatment with sulphuric acid one ton of coal yields something like [illegible]0 to 90 pounds of ammonium sulphate which can be sold for agricultural purposes at a price of about $12 per long ton This means that if coal dust or slack at 12 shillings per ton be used and a yield of 70 pounds of ammonia obtained the return in by products alone is about [illegible]0 per cent of the fuel bill

This is an important item and it is no wonder that attempts are made to keep the conditions such as will preserve this ammonia from decomposition What are those conditions? The temperature inside the producer must be kept below 600 degrees Centigrade whereas in the ordinary producer it is about 1 200 degrees Centigrade This means as we have seen before that an excessive amount of steam has to be used to keep down the temperature with a consequent deterioration in the quality of the gas In fact the content of carbon dioxide in a normal Mond gas is about 16 to 18 per cent The amount of steam used in the plant is about [illegible] pounds per ton of coal about five times as much as is needed to supply the best gas As only about 25 per cent of the steam is decomposed in the producer it follows that the free steam carried away by the gas takes away from the producer an enormous amount of latent heat with the natural consequence that the regenerative apparatus is both costly and cumbersome On the other hand it has been found that the sulphate cannot be profitably recovered with plants of less than 2 000 horse power so that for smaller sizes it scarcely justifies its existence and should be replaced by a simpler and cheaper type of plant The erection of towers filled with pipes for transferring the heat from water to air and *vice versa* is both costly and uneconomical In a test of a [illegible]00 horse power Mond plant it was found that the heat taken up by the air in the warming tower was only about 20 per cent of that carried by the water The gas should be split up into smaller sprays and the wetted surface presented to it be very much greater than is obtainable in these towers The dashers used too are very deficient in this respect and are of a very weak form The question facing the manufacturer who wishes to install gas producers for his engines is this—whether he will use his plant as an ammonia manufactory with gas as a sort of by product or whether he will use a reasonable amount of steam in the producer and use it to the best advantage for producing a fairly rich gas suitable for engine work The answer to this depends largely on local circumstances and no definite rule can be laid down to cover all cases To return to the tar it is found that however much the washing apparatus for these types may be multiplied tar globules have a knack of worming their way through them and ultimately finding their way to the engine cylinder Attempts have been made to split up the hydrocarbons by passing them through a hot zone inside the producer This may be done by inverting the combustion so that the air is introduced above the fuel and blown downward through the incandescent fuel It was effected in another way by Whitfield who drew off the tarry vapors from the raw fuel by means of the steam injectors and introduced them into the hottest part of the fire Other makers have a deep charging bell which forces the vapors to take a downward sweep before leaving the top of the fire These complications make the working of the plant more difficult and considerably add to its first cost The results obtained moreover are not commensurate with the extra trouble and expense as the tar cannot be reduced in this way by more than [illegible]0 per cent Most experts are of the opinion that the temperature of the producer is nowhere high enough to split up the tar and that the so-called fixing is merely a burning to carbon dioxide with a consequent deterioration in the quality of the gas In effect gases obtained by this method usually contain more dioxide than when the tars are unfixed It is generally considered therefore that the simpler method of washing or condensing out the tar is preferable to that of destroying by heat In this connection atmospheric coolers are both bulky and expensive besides being inefficient although they dispense with the use of water For extracting the tar I am of the opinion that by far the most efficient apparatus is a fan rotating in the gas at a very high speed A water spray introduced into the middle of the rotor is broken up into extremely fine drops which seize the globules of tar and dash them against the casing from which they drain into the settling tank These fans are very efficient in practice the power required to drive them is small and their water consumption is low For satisfactory cleaning it is advisable to send the gas through two fans in series Owing to the complex nature of the fuel it is only natural to expect that these bituminous producers and plants should be more troublesome and expensive than those designed for the simpler kinds of fuel Both the first cost and the upkeep of the former type are greater than those of the non bituminous variety and this increased expenditure forms an offset to the cheapness of the fuel The use of gas from bituminous coal for engine work is however a comparatively recent and we may expect that after more experience has been gained in the working of this kind of plant the results which are even now very creditable will make the gas plant a still more formidable competitor with other sources of power

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PRODUCTION AND USES OF TUNGSTEN

One of the most widely known of the rarer metals is tungsten The production of this metal in the United States however, is not large as a little of it goes a long way for some of its most important uses As by far the largest part of the tungsten produced is used in making tool steel the demand for tungsten decreased greatly during the recent depression in the steel industry In 1908 the domestic production of tungsten ore, reduced to an equivalent of ore carrying 60 per cent of tungstic trioxide (WO_3) the ordinary commercial basis in the United States was 671 short tons valued at $229 955 as against 1 640 tons valued at $890,048, in 1907 The statistics at present available from foreign countries show a similar decline These figures are taken from a report by F L Hess, of the United States Geological Survey published in an advance chapter from "Mineral resources of the United States calendar year 1908 Mr Hess gives also details of the industry by states notes on the occurrence and uses of tungsten and a partial bibliography

Tungsten is of wide occurrence but the individual deposits can hardly be said to be large As a rule they are pockety —that is they occur in lenticular masses or small shoots Many of those at the surface are quickly and easily mined but it may then take all the profits derived from the first ore body to locate another one

The tungsten minerals used as ores are hübnerite a tungstate of manganese wolframite a tungstate of manganese and iron ferberite a tungstate of iron and scheelite a tungstate of calcium They generally occur in veins cutting igneous rocks that contain much silica such as granite and granodiorite Some simple tests for identifying these minerals are described

The most important use of tungsten is as an alloy for tool steel to which it imparts the property of holding temper at a much higher temperature than high carbon steels When lathe tools are made of tungsten steel the lathe may be speeded up until the chips leaving the tool are so hot that they turn blue It is said that about five times as much work can be done by a lathe built for such speeds and work and fitted with tungsten steel tools as can be done in the same lathe with carbon steel tools From 16 to 20 per cent of tungsten is ordinarily used in lathe tools

There has been a widespread belief that most of the tungsten mined went into armor plate but it is stated by the *Ordnance Bureau of the Navy Department* that tungsten is not now and so far as known to that bureau never has been used in the manufacture of armor plate in this country and it is not known to have been so used in other countries though it has probably been used in experimental armor plates One of the most essential properties of armor plate is its ability to resist shock and this property is not imparted to steel by tungsten.

As the melting point of tungsten is very high—about [illegible] deg. C.—the metal is valuable for use as a filament in incandescent electric lamps, and such lamps are rapidly coming into common use. The whiteness of the light given by the tungsten filament makes it much superior to that of carbon, and the efficiency of the tungsten lamp is more than twice as great as that of the carbon lamp. Thousands of filaments can be made from a pound of tungsten.

Tungsten salts are used in fireproofing cloth for curtains, draperies, etc., in weighting silks, in glass making, as a mordant in dyeing, and for many other similar purposes.

HOISTING ENGINES AND BOILER PARTS.

THEIR PROPER DESIGNATIONS.

There is often a confusion of ideas as to the proper term to use when referring to any part of engineering apparatus, because a thorough knowledge of the machine is lacking. Often a false term is coined to designate some part because the true name is not known, different engineers using different names for the same part.

This applies to hoisting engines among other apparatus, and it is well for the reader to know the correct terms to apply to the various parts of a hoisting engine and the boiler. The accompanying illustrations of a Lidgerwood hoisting engine of the double drum type are presented.

In Fig. 1 is shown the engine and boiler complete with all visible parts designated by their proper names. Figs. 2 and 3 show more of the parts in detail. In order that a new part may be secured from the maker of any type of hoisting engine, the engineer should familiarize himself with the correct names, and then there will be no delay in getting the order filled, instead of having to write several times.

Generally manufacturers have a printed list and the names of the parts are designated by numbers, so that when a new piece is required all that is necessary is to write for the number corresponding to the name of the part wanted.—Power and the Engineer.

Arrangements have been completed whereby a standard clock at the Hamburg Observatory, Bergedorf, is connected to the trunk telephone system. A sounder automatically emits a siren-like note from the fifty-fifth to the sixtieth second of each minute—mid-European time—and this goes automatically to all the receivers connected at that time with the special exchange number which has been allotted to the time signal. Thus Hamburg and neighborhood and other towns of east Germany are supplied with a ready means of ascertaining the standard time.

BRONZE FINISHING BY MEANS OF THE BRUSH

F. Meyer, in his "Bronzewaren-Fabrikation," makes these observations with regard to the bronzing of metals by brushing on.

A good linseed oil varnish is essential. If the object is to have a gold bronze finish, rub up a little ocher as fine as possible on a grinding stone with the varnish, adding black and blue until the color looks a dirty green. Apply this to the object in two or three coatings with a soft bristle brush. The first two coatings must be thoroughly dry before a third is put on; the last one is to be coated, when but partially dry, with the bronze powder applied with a fine hair brush. The hollows or depressions in the surface of the object are not to be covered with the bronze powder. When the last coating of varnish is dry, the superfluous bronze is removed with a stiff brush. Instead of the ocher for coloring dark green, cinnabar may be used. Gold bronze is the natural color brought out upon brass and bronze by dipping or pickling, and it is then coated with a metal varnish, gold varnish or lacquer. Gold varnish is the chief factor in gold bronze, being the only means by which a beautiful and brilliant color is obtained.

Iron, zinc, tin and lead are given a gold bronze finish by application of varnish paint and subsequent coating or dusting over with leaf gold, mosaic gold or gold bronze powder. If cast iron objects are heated until they blacken, and brushed vigorously while hot with a brass or copper scratch brush, enough of the copper or brass will quickly be brushed upon them to give them the appearance of the latter metals, thus producing a red or yellow bronze. Brush until the objects have cooled to hissing heat. If the brushing were to be longer continued, the color would be brushed off again. The application of a good bronze lacquer will give a soft luster, and the objects will be hardly distinguishable from real bronze. The raised parts will be bright and the depressions dark.

For a silver bronze finish, apply to the object two or three coats of white lead, rubbed up in varnish as above and made silver gray (not too pale) by the addition of lamp-black, also rubbed up fine. The same rules are to be observed for drying as in the case of gold bronze. When the last coat is not quite dry, apply the silver bronze to the raised portions, proceeding exactly as in gold bronzing, the hollows of the object not being touched. Silver bronze is often used for parts of objects in contrast to gold bronze on other parts. Silver bronze can also be produced by coating the object with a lacquer or varnish paint and immediately applying mosaic silver or silver bronze powder as described above in regard to gold bronze.

Copper Bronze.—To copper bronze iron and zinc, coat the objects first with a brown varnish paint, and when this is nearly dry, apply copper bronze powder as in other cases. Copper bronze powder can also be mixed with spirit varnish and the two put on together.

The brown copper-like bronze for zinc objects consists of spirit lacquer with which is mixed a color rubbed up in alcohol. The objects must first be made perfectly bright and clean. Brushing and scratch-brushing with a fine copper brush will produce a red

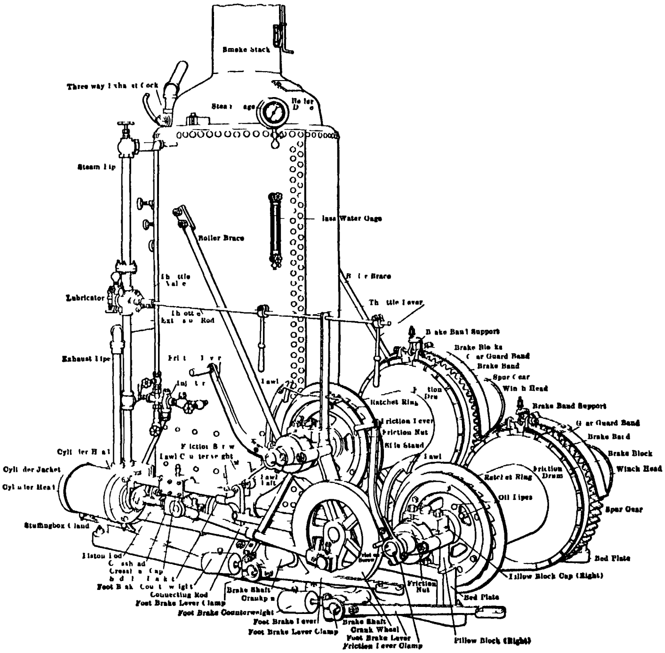

FIG. 1. NAMES OF BOILER AND ENGINE PARTS.

dish coating which is to be varnished over with a thin colored spirit lacquer.

Red bronze is produced by red bronze lacquer, red bronze powder or red mosaic gold. Before applying red bronze lacquer the objects must be made bright and clean, as every spot will show through. Warm them and put on the lacquer with a brush. If metallic bronze is to be used, coat the object first with a lacquer or varnish color, and when this is nearly dry dust on the bronze with a piece of velvet or a soft brush.

Green bronze can be produced on tin, zinc and lead by means of a green dead-luster bronze lacquer or a green varnish color. Frankfort black and chrome yellow make the best mixture for the color. Most bronzings for cast iron are lacquer or varnish mixtures, but they must not be too lustrous or the object will not look like metal; only a soft, subdued luster has the appearance of genuineness.

Sheet metal objects are also bronzed by first lacquering them and, when the lacquer color is dry, applying metallic bronze, red, yellow, gold, white or silver, by wiping it on. Before lacquering, the objects must be rubbed with powdered pumice stone, ashes or hartshorn. Fine articles should be polished after each application of the varnish, except in some cases the last. If there are figures, flowers or other decorations, the final polishing is not to be done until after the painting has been varnished. Sheet metal objects are usually coated with a light colored transparent varnish after the bronzing is finished.

For small objects of cast zinc only the best and oiliest lacquers must be used, otherwise they would soon be spoiled by the action of water. If such objects have been cast in sand molds they must be well chased. In the case of large objects of cast zinc, such as chandeliers, etc., chasing is not necessary, provided the casting was successful, as the lacquer will conceal many rough or imperfect places. The lacquer colors for cast zinc objects of monumental size must not be too brilliant, but should have a dull, quiet tone; the luster can indeed be subdued by rubbing on metallic bronze, but the effect is more beautiful where this has not been done.

Bronzing by the application of lacquer colors requires first of all practice, also taste and a sense of beauty to guide in the selection of the right tones. There are different shades of all the colors, and the workman must have good judgment in choosing them to suit the object to which they are applied. With metallic gold, red or silver the beauty of the effect will lie in the contrast of the darker colors of the hollows and the lighter bronze of the raised portions, and it is essential that the bronzer should know how to produce a gradual transition from light to dark and how to make the shading appear natural. There are no rules for this; artistic perception is often the only guide, and experience is the best teacher. Hartmann says that metals can be most finely bronzed when perfectly bright and clean, and that by skillful application of the bronze with a soft brush and rubbing it in, the luster can be varied in different portions of the bronzed surface as its nature may demand. It is also recommended to rub the surface lightly with linseed oil before applying the bronze.

It is certainly true that the bronze will adhere more easily and firmly to the oiled surface than to clean metals, but on the other hand the fatty acids contained in the oil will act upon the bronze coating, which will in consequence soon lose its luster and become green by the formation of copper oleate.

Another method is to smear the objects with a highly diluted solution of paraffine in gasoline, and let this coating dry. The very thin layer of paraffin which remains on the metallic surface has a similar effect to that of the oil in helping to make the bronze powder adhere, but with this difference, that it does not act upon it chemically.

Mosaic gold is to be mixed with 4 parts of washed chalk to 1 part of gold and applied to the copper or brass object with a moistened wad of linen; the metal will take on the appearance of gold, and the coating can be protected by a good elastic lacquer.

Iron objects are first to be coated with green cinnabar and powdered over, when the coating of cinnabar is dry, with mosaic gold, using a large, soft hair brush.

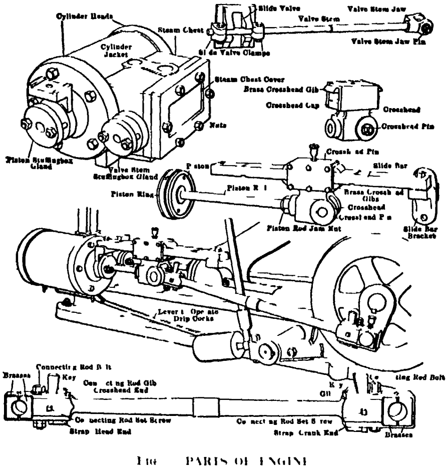

FIG. —PARTS OF ENGINE

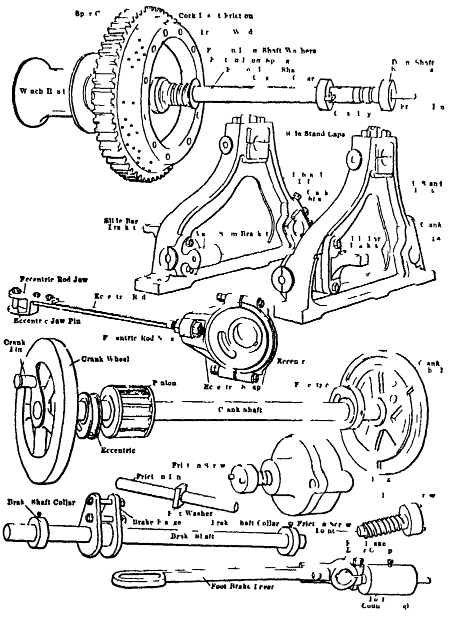

FIG. 3.—PARTS OF CRANK AND DRUM SHAFTS AND FITTINGS

RIVER GAGINGS

The river gagings conducted by the United States Geological Survey are again threatened with complete abolition, for the sundry civil appropriation bill recently reported to the House contains no appropriation whatever for the work. The value of these gagings is so great in connection with irrigation, power, flood prevention and water supply enterprises that the continuation of the work is very desirable. A break of a year or more in the records of stream flow would be particularly unfortunate, for it is only by a study of consecutive gagings covering many years that safe estimates for great engineering undertakings can be prepared. Every engineer acquainted with irrigation and power works can cite cases where large sums of money have been wasted on account of insufficient information regarding the seasonal and annual fluctuations in the discharge of rivers. Now that it seems likely that those who receive federal grants for water rights of one sort or another will be required to compensate the government for these privileges, there is still further need for carrying on the gagings. The remarkably low cost of the gagings, the excellent organization for doing the work, which has been developed only after years of experience in selecting and training the observers, and the general willingness to assist in furnishing data evinced by engineers and riparian proprietors, would be largely undermined by a failure to make the necessary appropriations for even a year. The same fate threatens the fuel testing and structural materials testing conducted by the Geological Survey, for the appropriations in the bill for such investigations are so small as to be wholly inadequate for any real progress. The National Advisory Board on Fuels and Materials is practically abolished by the bill, for it contains no appropriations whatever for its expenses. Its members have never received any compensation for their services, but their traveling expenses have heretofore been paid. In view of the great value and extraordinarily low cost of the work done by the hydrologic and technologic branches of the Geological Survey, it is to be hoped that Congress will not curtail it in the manner proposed by the bill.—Engineering Record.

ILLUMINATING ENGINEERING.*

ITS GUIDING PRINCIPLES.

BY PROF. SILVANUS P. THOMPSON

For practically a century only have there been any systematic means of illumination in use in any civilized country. Before the year 1800 there were as means of illumination daylight, oil lamps, rush lights, tallow dips, and wax candles. Monarch and peasant, merchant prince and workman, had alike to depend on individual sources of light at night. Only in the larger towns and cities was there any organized attempt to light the streets by oil lamps. In 1811 the authorities of the day stoutly resisted the proposal to light the then House of Commons by gas; nothing but wax candles could be admitted. But gas lighting was coming in, and Argand and colza oil lamps were the sole competitors until after 1850. Everything else dates since then, practically during the last half century. For kerosene lamps were not widely spread until the sixties. Arc lighting, though tried for spectacular and lighthouse purposes from the fifties, did not come into public question until about 1878. Glow lamps followed three or four years later. Still later came incandescent gas mantles and acetylene gas lights, while the newest things in both gas lighting and electric lighting are affairs of only a year or two ago. Many persons now realize the immense stride made in the introduction of the Auer (Welsbach) mantle for incandescent gas; very many fewer people realize the significance of the corresponding step forward that has been begun by the introduction of the metallic filament glow lamp. We are on both sides in the very middle of an immense evolution in the art of illumination.

But while the means of illumination have thus been developing with amazing strides during a single generation, and the organized systems of distribution by municipal and urban and rural authorities and by private corporations have ramified throughout the community and brought supplies of gas and of electricity—shall I also say to all of our doors?—there has been another and very different development going on. I refer to the growth of that branch of the science of optics which deals with the measurement of luminous values. Photometry has been growing into an exact science by the explanation of its laws and the improvement of the instruments of measurement. It was not until 1760 that the first real discussion of photometric principles was made known. In that year Lambert, in his "Photometria," laid down the fundamental laws, and likewise in the same year Bouguer gave to the world his "Traité d'Optique," wherein a primitive photometer was described. Rumford's shadow photometer was invented in 1794, and Ritchie's in 1824. Then comes a long gap. Save for Bunsen's over-rated grease-spot instrument, there was no important advance in photometry until the eighties, when there were produced many novel forms, some of them, including the now well-known forms of L. Weber, Lummer-Brodhun, and Rood, capable of yielding results of much higher precision in the comparison of different sources of light. Also in the eighties we meet for the first time with special forms of photometer of the kind destined to play a very important part in the work of our society, namely photometers measuring the values, not of the brilliancy of a source of light, but the illumination of a surface.

Our primary concern is the adequate and proper illumination of things, and as we have to reduce the present chaos to an exact science, our first business is to secure some common agreement as to the measurement of illumination and the establishment of reasonable rules as to the amounts of illumination required in different cases.

Foremost, then, in the programme of work for our society we put the question of the units of measurements and the promulgation of the proper definitions of them. We must secure agreement, national and if possible international, as to what shall be taken as the unit of light and what as the unit of illumination of a surface.

Happily the long-standing controversy as to the [illegible] appears to be settling itself by at least a preliminary agreement between the standardizing laboratories of the great nations. One candle is no longer to be a vague and indefinite thing. The new definition provisionally agreed upon is an ideal unit in terms of which we can describe the several standards in use in different countries. If this provisional *entente* can but be ratified by a little international common sense, we shall have henceforward an international candle, such that it is the same in England as in America, equal to the *bougie décimale* accepted in France, and related to the Hefner candle of Germany in the precise proportion of ten to nine.

But we have still to find agreement on the standard of illumination. Here in England and in the United States we have already grown accustomed to describe amounts of illumination of surfaces in terms of a British unit, the candle-foot—not perhaps a very happy term, one that we would readily exchange for a better—meaning thereby the intensity of illumination at a surface situated at the distance of one foot from a light of one candle. The source being assumed here to be concentrated at a point, the law of inverse squares holds good.

Adopting the candle-foot as the unit of illumination, one may readily state certain facts with definiteness. All competent authorities are agreed that at night for the purpose of reading an illumination is required not less than one candle-foot, some authorities saying 1½ candle-foot. The facts appear to be that reading is impossible with an illumination of one-tenth candle-foot, difficult and fatiguing with one of one-fifth candle-foot, comfortable with from 1½ to 3 or 4 candle-foot, but that if the illumination exceeds 6 or 8 candle-foot the glare of the page is again fatiguing and dazzling. The page should neither be under-illuminated nor over-illuminated. Something depends, it is true, on the size of the print. Under a feeble illumination of say ½ candle-foot a type of pica size printed in a fount of bold face properly inked is legible, when one of long primer size printed in a weak way would be practically illegible. Something also depends on the state of the eye as affected by the general illumination of the surroundings. Very seldom does one find in any ordinary room an artificial illumination exceeding 1 candle-foot. By day on a writing table placed near a north window, or near any window not receiving direct sunlight, the illumination may exceed [illegible] and may even attain 4 or 5 candle-foot.

Until a unit of illumination was thus agreed upon it was impossible to render any reasonable certainty to estimates of the amount of illumination in any case of dispute. What is the meaning of the term well lit as applied to any room, building, factory, workshop, or school? Formerly the term was entirely vague. To-day the answer can be given in numerical terms. Formerly judgment had to be made by the unaided eye, and the eye is notoriously a bad judge. As between two different illuminations the powers of discrimination of the eye are very limited. The eye can equate, but it cannot appraise. It can tell with fair accuracy whether two adjacent patches are equally bright. If they are not equally bright it cannot say with any kind of proportionality what their relative brightnesses are. All photometry depends on the perception of an equality.

Photometers for the measurement of illumination have been mentioned earlier as coming first into notice in the eighties. One of the earliest in this country was that constructed by Sir William Preece, with the assistance of Mr. A. P. Trotter, for measurement of the illumination of sidewalks and pavements of streets. It has been subsequently developed by Mr. Trotter, and as constructed by Mr. Edgcombe is a most useful and handy instrument, telling the amount of illumination directly in terms of the candle-foot. Another by Mr. Haydn Harrison measures the illumination not on the horizontal but at 45 deg. Almost equally early with the Preece-Trotter illumination photometer was the school photometer of Petruschewsky, apparently little known in this country. Most recent of this sort is the form due to Martens.

The principles and construction of photometers are matters that have interested me for nearly thirty years. About 1880 I brought out a form of wedge photometer (modified from Ritchie's form) in conjunction with Mr. C. C. Starling for electric light measurements. Later I gave to the Physical Society an investigation of the errors arising in photometry from the almost universal assumption that the law of inverse squares is fulfilled. In 1882, when lecturing at the Crystal Palace Exhibition, I gave diagrams to show the effect of the superposition of illumination from two or more lamps, and discussed the variations of illumination in a street between the places of maximum and the places of minimum illumination. Twelve years ago I described a tangent photometer which has remained a mere optical curiosity.

No one can have worked at the photometry of modern lamps, or of the illumination of surfaces lit by lamps, without becoming conscious how much misunderstanding there is of the elementary laws of illumination. There is Lambert's cosine law, admirable and simple if only it were so, in so many cases vitiated by the presence of organized—that is, specular—reflection. There is the law of inverse squares itself, a universal geometrical law of action radiating from a point, so fatally and absolutely misleading if applied to any other case than that of action from a point.

One subject on which more information is badly needed is the specific brightness of surfaces of different kinds when subjected to a standard illumination. For instance, how much light is reflected per square inch when illuminated with an intensity of 1 candle-foot from such materials as oak paneling, whitewash, brown paper, or the surface of a red brick wall? Here in this theater the walls are tinted of a dark Pompeian red or maroon, which reflects but little light. The extra annual expense of lighting that might be saved had a lighter tint been used is surely worth considering.

The subject of diffuse reflection, which here comes into play, has indeed been investigated partially by several persons. There are Dr. Sumpner's researches of 1891 and those of Mr. Trotter on white cardboard and other white matt surfaces, but how few others! Again there is the subject of diffuse refraction, which occurs in ground-glass shades, ribbed and corrugated glass panes, and other devices for diffusing the concentrated light of lamps. Yet how little does any optical book tell us on the subject of diffuse refraction. Reflection and refraction as they occur at dull or irregular surfaces appear to be of no importance to the academic writer of text-books of optics, but they are of vital interest to the illuminating engineer. Again there are a number of semi-physiological problems that demand investigation and settlement. We all know that our eyes have an automatic diaphragm which stops down the entering light to protect our eyes from glare, rendering us relatively insensitive to bright lights. Does anyone know whether the contraction of the pupil depends on the total amount of light entering the eye or on the intensity of the image on local patches of the retina?

Again, we all know how an unshaded arc lamp, or even glow lamp, cuts the eyes by the very concentration of its beams even when it may be many feet away, while the same actual amount of light, if diffused over a greater apparent surface, as by a surrounding globe of ground glass, is quite readily endured and does not produce the same painful sensation. Does anyone know how great is the specific brightness of surface that the eye will tolerate without experiencing this discomfort? We can look at a white cloud or at the blue sky without pain. Can we endure a specific brightness of so much as one-tenth of a candle per square inch?

Our eyes are provided by nature with a most exquisite and automatic iris diaphragm, which opens in the dark and closes in the light, thereby shielding us partially against the evil effects of glare. Putting it in the language which the photographer uses to describe the stopping down of a camera lens, the automatic iris of our eye can close the pupil so that while in a comparative darkness the aperture opens to $f/2$ or $f/2.5$, it closes amid a brilliant surrounding illumination to about $f/20$. Suppose we are looking out in relative darkness and are confronted with a brilliant patch shining with a specific brightness of one-tenth of a candle per square inch, we shall feel a certain amount of discomfort from its glare, and if we regard it steadily for a second or two will, on closing our eyes or turning away, see those persistent colored images that trouble us after looking at any very bright light, but now let the same brilliant patch be placed against a bright background. Far more light will enter the eye; the automatic iris of the eye will in a few moments have contracted, stopping down the lens of the eye so that it will be far less sensitive. In these circumstances will the patch that has a specific brightness of one-tenth candle per square inch pain or dazzle the eye? I ask the question, but I do not know the answer. Does anyone know what the answer ought to be? It is a simple question, and a few experiments would soon settle it. Of course one must admit that the automatic action of the iris diaphragm, important as it is, does not by any means account for the whole of the facts about the want of proportion between the intensity of a stimulation and the intensity of the resulting sensation. Fechner's logarithmic law of psychophysics gives a clue, but even this does not seem capable of expressing, much less of explaining, the facts about the observed want of proportionality. Why should a light of tenfold brilliancy not produce a sensation ten times as intense? And why should a greater brightness of the general surroundings relieve us of the annoyance of those colored after-images? After-images can be seen even under extremely feeble illumination, as I have again and again found. Has anyone discovered any exact law governing their occurrence?

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* Abstracted from the inaugural address delivered at the inaugural meeting of the Illuminating Engineering Society.

All these queries show that there is plenty of work awaiting us even in the mere collection and completion of such scattered information as is already available, but there are even more important questions before us, more important not in science, but in their relation to the public welfare and the economics of the community.

Now that we have a standard of illumination and simple portable instruments that will measure it, there can be no excuse for inaction or ignorance in applying that knowledge to securing proper illumination for public and private buildings.

Let me begin with school buildings. They are the most important, for whatever bad results flow from bad lighting of churches, factories or railway stations, those which result from the bad illumination of schools are far more to be deplored—they imperil the eyesight of the next generation.

All ophthalmic surgeons agree that the cause which forces the children into increasing shortsightedness is protracted poring over books under an insufficient illumination. Even in what an inspector might call a well-lit school the illumination at the surface of the desk may be quite insufficient if the desks are badly placed, or the windows insufficiently high, or the lamps badly distributed.

All educational authorities ought henceforth to insist on rational requirements as to lighting. Hitherto they have had nothing definite to specify; now that illumination photometers are available, they ought to require a minimum of 1½ candle-foot at the worst lighted seat in the schoolroom, and not depend on purely architectural rules about heights of windows or areas of window space. In England the Board of Education in its Building Regulation (1907) Rule 6 clause c has laid down a foolish rule: "Skylights are objectionable. They cannot be approved in school rooms or class rooms." That perfectly monstrous provision ought to be at once repealed. The universal experience of the textile industries, where adequate lighting of spinning and weaving machinery is a prime necessity, is that no method of lighting is so satisfactory as skylights in roofs specially constructed to receive light from the northern sky.

Hitherto little attention has been paid by either local or central authorities to conditions affecting the lighting of factories and workshops. It is true that the factory inspectors require periodic whitewashing of factories, but that is for sanitary reasons, not primarily to secure better illumination. The Home Office has its regulations as to temperature and degree of moisture required or permissible in the different classes of factories and workshops. Then why not also similar regulations as to the proper amount of illumination? Surely the eyesight of the workers is as well worth protecting from injury as their lungs and their limbs. So far as I am aware, Holland is the only country in which legislation has fixed a statutory amount of illumination in factories, the figure there being from 10 to 15 candle-meter, equivalent therefore broadly to the value of 0.9 to 1.4 candle-foot.

Architects are often blamed for deficiencies in the lighting of the buildings they design, perhaps more often for the deficiencies found at night by artificial lighting than for those of the lighting by day. For this the fault rests no doubt largely with the persons who has installed the lighting arrangements, and one must not blame the architect too severely for having been as ignorant as all the rest of the world about the principles of illumination. But henceforward, when once it is known how much illumination is required in the rooms of different kinds, the architect ought in his specifications to set down, with appropriate numerical values, what degree of illumination is required in the various parts of his building.

I venture to suggest that it would be a good thing if some committee could draw up a model specification or model clauses for architects to insert in their specifications, in which the proper way of prescribing the requisite amounts of illumination in different classes of cases should be set forth.

THE ELECTRIC LIGHT IN MEDICINE.*

DIFFERENTIAL INDICATIONS FOR ITS USE.

BY A. D. ROCKWELL, M.D.

There is no more important and efficient method in its relation to therapeutics than the application of light and heat, and although much has been written about it, and much use has been made of it, yet from the standpoint of those who from personal experience fully appreciate its value, it seems surprising that there is not a more universal recognition of its varied therapeutic properties.

In the few remarks that follow on light therapy it is not my thought to include the whole of phototherapy. I do not propose to discuss the Finsen light, which is a very important part of phototherapy, but for the information of those who have a confused idea of what constitutes the Finsen light, and imagine that it is a very simple and easy thing to get, a word may fitly be said. The Finsen light, whether derived from sunlight or the electric arc light, exerts only actinic or chemical effects. In Finsen's original installation an arc light of 20,000 candle power was used, and the intense heat thus developed had to be absorbed by an elaborate cooling process before the ultraviolet rays were available for practical and efficient use. The original Finsen lamp required 80 amperes of current and 60 minutes of exposure, but with simplified apparatus good work can be done with five amperes and less exposure. Strictly speaking, the essence of the Finsen light is not light at all, for the ultraviolet frequencies of infinite rapidity are no more visible than the still higher frequencies of the X-ray, or the far lower frequencies that we appreciate as sound or heat. The effect of the so-called Finsen light then is local and superficial, of remarkable value in the treatment of skin affections, but of little worth in deep-seated morbid conditions.

The ultraviolet ray has no power of penetration. It is immediately absorbed by the blood, and even when the parts are rendered anemic by pressure or by adrenalin and cataphoric action, its penetration is still comparatively superficial. Used alone and uncombined it exerts no general constitutional effect and acts only on the periphery, but as Finsen demonstrated is invaluable in dermatological cases, and especially in the treatment of lupus. It cannot be too often repeated that the difference in forms of physical energy is one of degree rather than of kind. The three things that go to make up a complete light treatment, or phototherapy, are the heat, light and chemical rays, which are simply different rates of vibration. Sound, which is a lower rate of vibration, we do not regard of therapeutic value, but as vibrations increase in frequency and decrease in length we get the heat rays, then light (the visible spectrum), until finally we enter the region of the invisible (the ultraviolet), and beyond this the X-ray. Light, heat and chemical energy constitute the trinity of phototherapy. These combined effects are undoubtedly represented best by the rays of the sun—which when concentrated act more powerfully than those from any artificial source, but for obvious reasons their general and successful utilization is impracticable.

The two available artificial sources of this method of treatment are the incandescent lamp and the arc light, either of which are superior both in physiological and therapeutic effect to the ordinary hot air bath, for the reason that the latter is more depressing and far less penetrating than radiant heat, and is without chemical activity. In the administration of light energy one should bear in mind an important fundamental principle, viz., that resistance develops energy, a principle as striking on its moral and intellectual side as on its physical. Electricity, for example, is of value therapeutically only as it meets with resistance, and in the same way light cures disease only as it meets the resistance of the human body and is transformed into radiant energy. The rays from a powerful incandescent or arc lamp readily penetrate the skin, but in overcoming the deeper and denser structures are converted into heat. Heat, therefore, is one of the principal therapeutic factors in the use of the electric light.

It may be observed further that radiated heat as developed by the incandescent and especially by the arc light results in a more rapid and powerful dilatation of the superficial vessels than the action of simple hot air, and this relaxation of vessels, because of no appreciable heating of the surrounding air, can be continued indefinitely. These light rays exert a remarkable stimulating effect upon the peripheral nerve endings and may be utilized to excite perspiration more quickly than any other method. The superior efficiency of this form of radiant energy is increasing oxidation and tissue changes are evidenced by the elimination of carbon dioxide. As indicated by this elimination, oxidation goes on far more rapidly under the influence of radiant light than of simple hot air. Another well recognized and important factor in the light treatment, more especially the arc light, is its action on the blood. The hemoglobin carrying power of the red corpuscles is demonstrably increased, and through the influence of its invisible rays upon micro-organisms we get pronounced bactericidal effects.

My first experiences along this line were with the incandescent lamp, not the ordinary incandescent light bath made up of many small electric bulbs inclosing the body of the patient, but of a single lamp of 500 candle power.

Placed within a cylindrical metal hood and suspended by a convenient mechanism, the light can be easily applied to any and all parts of the body. For the relief of pain, and especially in the treatment of neuritis, it is invaluable.* I even went so far as to say that in the relief of local painful conditions and in its general constitutional influence it was superior to the arc light. In this I believe I was mistaken. After a more extended experience in its use I do not hesitate to assert that while the arc is quite as valuable as the incandescent light for the relief of pain, its influence upon defective blood and skin conditions is far superior. From what has already been said as to the composition of these two manifestations of light, it is not difficult to understand why this may be so. Both are forms of radiant energy, but in the incandescent or leucodescent lamp the glass globe effectually intercepts the chemical rays, while the arc light with no intercepting barrier gives the full value of the concentrated solar ray. While therefore theoretically it is no difficult matter to decide upon the relative value of these two forms of light and to rule as to some differential indications for their use, practically it has not been quite so easy. Many cases had to be treated some by one method, some by the other, with results on the whole seeming to indicate the greater efficiency of the arc light, but it was not until the two methods were successively used in the treatment of the same patients that the superiority of the one method to the other became strikingly manifest.

Briefly stated, the superiority of the arc light to the incandescent in the treatment of certain local surface conditions and conditions constitutional and general is due to the fact that with light and heat are combined the subtle chemical reactions which are wanting in the other. The arc light represents all the rays of the spectrum, as does the sun itself, and practically it is nothing but sunlight. Fortunately, however, for our therapeutic purposes, it is far more controllable than sunlight, and can instantly be made intense or mild, concentrated or diffused, and even the different light rays selected or excluded at will.

Soldering ordinary platinum vessels is commonly done with platinum itself as the soldering material, or with pure gold, using the oxhydrogen blow pipe or its equivalent melting flame. Gold has the disadvantage that it melts at a lower temperature than the platinum, and under temperatures to which crucibles or other vessels may be subjected it melts and leaves the crack open. In Central Zeitung fur Optik und Mechanik it is recommended to close the crack with a mixture of platinum powder and turpentine oil, then to heat the joint to a white glow, and in this condition to hammer the parts together. Another method, applicable where the crack is on the edge, consists in hanging a narrow strip of platinum sheet over the crack, then placing the article in the fire, heating it white hot and hammering if necessary. According to Metall Arbeiter a small hole may be closed by a rivet made of platinum wire welded after hammering both heads closely. For larger holes a patch is made of platinum sheet.

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* Medical Record.

* See article on "Phototherapy in Neuritis," Medical Record, November 9th, 1907.

CARTAGENA: "THE HEROIC CITY."*

A TOWN WITH A MELODRAMATIC HISTORY.

BY ISAAC A MANNING.

CARTAGENA DE INDIAS, as it was termed by the ancient governments on the north coast of the republic of Columbia, now spoken of in Colombia as the Heroic City, has more of the tragic and melodramatic in her history perhaps than any other city in the western continent. The stage settings about which the many events took place seem not to have been yet arranged to the various effects in the tragedies and dramas which occurred in the earlier periods of its existence.

Older than any city of America and the new world except Santo Domingo and Mexico, and founded by virtue of royal decree which declared it a very loyal and loyal city, it has retained more of its early characteristics perhaps than all the others. The medieval flavor surrounds it. Its antiquity is everywhere in evidence and the air of romance hangs over it. One feels it, sees it, hears it at every step within its old battlemented walls.

When Bastidas first took refuge within its harbor in 1501 he declared it the natural point for a city, and Pedro de Heredia, who was to govern it through many vicissitudes and finally die in shipwreck on the shore of his native land whither he had gone to answer charges of his enemies, was given the first warrant as Governor of Cartagena. He established the city in 1533 and the following year the King of Spain sent there a bishop of the church. From that time to the end of Spanish rule no place on the Spanish Main suffered more changes from prosperity to adversity and vice versa.

Here came the gold of the Perus for shipment to Spain, and as the capital it was the center of attraction for all sorts of adventurers. The frequent visits of pirates and buccaneers led the King of Spain to authorize the wonderful series of defensive works which encompass the town and harbor and which stand to-day as monuments to the constructive skill and engineering craft of the old Spaniards. The ramparts, battlements and general series of fortifications are so constructed that they are declared faultless from the view point of military engineers. They are all remarkably well preserved and are unique in that their counterparts are not to be seen anywhere else in the new world. Built of coral stones, many of them so huge in size one wonders how they were handled, they are laid in a concrete, the mixture of which seems to be an entirely lost art. This is proven through efforts of the modern workmen to repair breaks in walks and walls, which repairs show no such strength as the old works of centuries ago.

Here came, before these muniments and donjons were built, such jolly visitors as Robert Vaal, Martin

LOZANO STREET—A TYPICAL STREET IN CARTAGENA.

A PART OF THE WALL SURROUNDING CARTAGENA.

CARTAGENA, THE HEROIC CITY.

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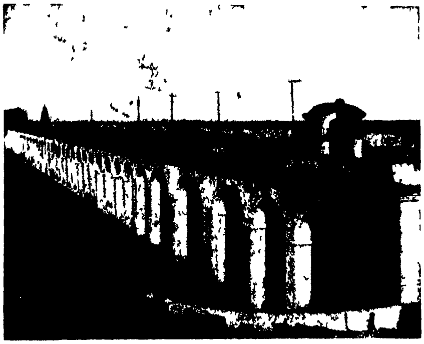
* Bulletin of the International Union of American Republics.

Cote Sir Francis Drake, the Sieur de Pointes, Du Casse, and other rovers, each being remembered by what he took away rather than by what he left and the scenes of their exploits are pointed out Among others at the old convent of Santa Candelaria on the top of the hill called La Popa lying back of the town and which serves as a landmark to mariners passing that way the white or light yellow buildings being visible for many miles at sea one is shown where one of these gentlemanly fellows in the spirit of mediately near Cartagena for in that hill lived the malignant spirit which was worshipped in the form of an animal by the Indians and whose worshippers called the spirit [illegible] Uri Busilacu Vent This idolatry it is reported was confessed by a man of mixed blood, Luis Andrea by name many years afterward Andrea was said to have had a pact with the devil and this fact and his other sins were found out by the famous Holy Office or Inquisition in its own mild and persuasive way To show its full apprecia mingo occupied as a Dominican monastery today and for which the King of Spain in 17[illegible]0 authorized the collection of money to be used in its repair stating that owing to its antiquity this convent is rapidly falling into ruin It was erected in 1[illegible] and is a most enchanting old place with a church in which are three wonderful altars [illegible] cathedral was erected soon after and in this will be found paintings of all the former bishops and [illegible] beautiful samples of wood carving [illegible] the finest samples of



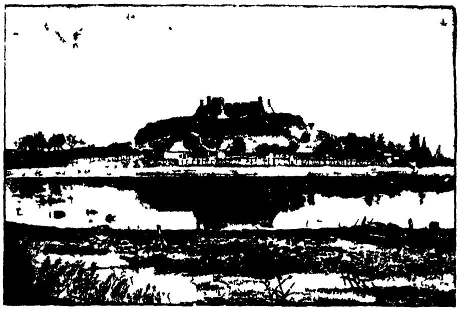
A SECTION OF THE HISTORIC WALL OF CARTAGENA COLOMBIA

Erected by Spain at a cost of $5[illegible] for protection against pirates Cartagena was the port whence Peruvian gold was shipped to Europe and is now one of the leading ports of Colombia

THE BATTLEMENTS OF [illegible] SAN FELIPE DE BARAJAS CARTAGENA WHERE VERNON'S ATTACK WERE REPELLED

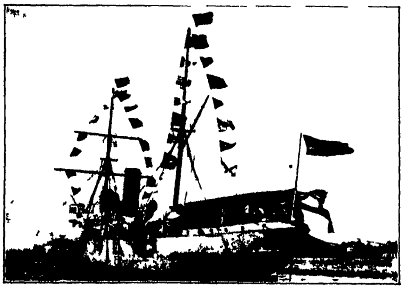
It [illegible]

STREET SCENE IN CARTAGENA



THE OLDEST FORTRESS IN AMERICA CARTAGENA

A CORNER OF THE BATTLEMENTED WALL CARTAGENA



COLOMBIAN MAN OF WAR CARTAGENA FORMERLY THE PRIVATE YACHT OF THE SULTAN OF MOROCCO

CARTAGENA THE HEROIC CITY

pleasantry which so frequently manifested itself among them is said to have hurled the nuns who then held solitary worship there over the edge of the perpendicular cliff on which the monastery and convent stood

This old convent, one of the points which would first attract the curious attention of the tourist was founded in 1608 and in the story of its foundation it is said the Holy Virgin appeared to Friar Alonzo de la Cruz Paredes then at Bogota ordering him to go at once to Cartagena and there erect a convent on the top of the first high hill which he should see immediately

tion of Andrea's confession report says the court mentioned had him burned at the stake

The Inquisition sat here from 1610 to 1821 and among the many interesting structures of the city is the house now occupied as a private dwelling where the famous judicial body held its court

There are any number of wonderful old churches in all styles of architecture and in all conditions of repair or ruin now being occupied for all manner of uses Many of them date from the sixteenth century but the greater number were erected in the seventeenth Among the older is the convent of Santo Do

Italian marble in the new world There is a pulpit which is said to have been intended for Lima Peru The ship in which the pulpit was shipped was wrecked at Cartagena however and the pulpit is said to have floated ashore Reshipped later the second vessel met the fate of the first according to tradition and the altar again appeared upon the beach This was taken as an evidence of the Divine will that this altar should remain at Cartagena However that may be it is there and admired by every lover of sculpture who sees it

One of the prettiest chapels of the city is in connection with the hospital formerly the convent of the

Santa Clara nuns In this the altar is a wonderful piece of gilded carving and the pulpit erected nobody seems to know when is of the most artistic workmanship inlaid and the panels set with beautiful paintings

In the church of San Pedro Claver lie in a vault beneath the altar the bones of the famous saint whose name the church bears Visitors are shown these bones which seem to bridge the chasm of centuries when it is remembered Claver's service as priest to the negroes was in the early seventeenth century These are the remains of America's only saint so far as I can learn he having been canonized by Pope Leo XIII in 1888

In fact nearly all the old churches and their contents where the church buildings have not been taken for other uses are worthy both time and study for I believe that little is known of their real treasures and that Cartagena is so little known is a source of wonder to anyone who has an opportunity to see its quaintness and know some of its rare antiquities

San Felipe de Barajas an old castle and fort lying on a low hill overlooking the city is full of interesting underground passages as are many of the fortifications and although utterly abandoned and falling into ruin is still a formidable stronghold

Tradition has it that the underground passages entrances to which are open and which in recent years have been explored for short distances formerly connected the stronghold with the convent of Santa Cruz de la Popa on the Popa and also with the house of the Inquisition the cathedral and the church of San Pedro de Claver which was formerly the church of St Jean de Dieu

San Felipe was the most formidable of all the series of intrenchments outside the city walls and withstood the attack of the British Admiral Vernon's soldiers after he had captured all the other forts about the harbor

One thing that lends interest to the history of this old castle and Vernon's memorable siege of Cartagena in 1741 is that Lawrence elder brother of George Washington was the ranking captain of colonial troops under Vernon and that without doubt he took part in the attack on this old fort which ended in the defeat of Vernon's effort to capture Cartagena Colonel Washington died after his return to Virginia from a disease contracted while engaged in that campaign He visited the islands of Barbados Trinidad Nevis etc seeking health and George Washington accompanied him for a while but he soon returned home to his deathbed It was Colonel Washington's connection with Vernon in this siege of Cartagena which led to his naming his country seat Mount Vernon which place after his death became the property of his brother the future Father of his Country It is well known that many of Vernon's troops in his attack on New Spain were from the colonies

In this article there is room to touch but incidentally on the riches of antiquity which lie open to the usual traveler who visits the heroic city But I feel sure without entering upon the odiousness of comparison that no other city on the West Indian route of tourist travel offers so much of interest to the sightseer as does Cartagena the old capital of New Spain

CARTAGENA HARBOR.

VIEW OF CARTAGENA

CARTAGENA THE HEROIC CITY

HEAT TRANSMISSION

The earlier race of steam engineers undoubtedly achieved a very substantial success with but a very limited knowledge of the principles of thermodynamics a knowledge which indeed can hardly be said to have existed during those days of pioneering Few of us however nowadays are satisfied with knowing that a certain procedure will give rise to certain results Like the Elephant's Child of Kipling we are endowed with insatiable curiosity and are certainly not content with the fact that a particular design of steam engine will develop 1 horse-power per hour for every 1½ pound of fuel but desire to know the origin and each of the individual losses which in the aggregate prevent us from obtaining in the form of useful work more than some one seventh of the chemical energy originally existent in the fuel consumed It cannot perhaps be claimed that the detailed analyses of the various sources of loss have led to any very notable improvement in this ratio but the mere assurance that the bulk of these losses are inherent to the conversion of the heat into mechanical work has undoubtedly saved much misdirected labor and enabled the engineer to concentrate his attention on the problem of reducing to a minimum the non inherent losses

The steam boiler though as old as the steam engine has been studied much less minutely so far as concerns the principles involved in the transmission of the heat from the fuel to the water At first sight indeed the field for successful research appears less attractive In one way or another an efficiency of heat transmission of between 70 to 80 per cent has long been attained with boilers of practically every pattern and to leave well enough alone is a very good rule in the practical business of life whatever it may be in philosophy and science The enormous discrepancy however which an elementary calculation shows to exist between the conductivity of iron as accurately measured in the laboratory and its apparent conductivity as realized in boiler practice was however far from satisfactory once it was realized and engineers are certainly much indebted to those laborious investigators who have cleared the matter up

It may now be taken as certain that in ordinary boiler practice the metal on the fire side of a tube is never more than a few tens of degrees hotter than the water which it is converting into steam although the average temperature of the gases passing through may be 1 000 deg F or more In fact the interchange of heat between a gas and a solid takes place with exceeding difficulty in spite of the remarkable mobility of the gaseous molecules It seems indeed to be satisfactorily proved that in ordinary conditions the surface of a boiler tube is separated from the core of hot gas passing through it by a very thin film of cool and nearly non conducting gas which as it were blankets the surface Mr Mark Robinson has suggested that this cool film consists of molecules which have lost their velocity in communicating their kinetic energy to the molecules of the plate This is probably true but it would seem that each molecule must make many contacts with the plate before it can deliver up to it any considerable proportion of its energy This will certainly be the case if the transference of energy is governed by the rules applicable to the collision of perfectly elastic spheres In the solid condition the molecules of a metal probably consist of many atoms and weigh therefore perhaps 200 times as much as the molecules by which they are bombarded If however a very light but perfectly elastic sphere in rapid motion strikes a very heavy elastic sphere at rest it rebounds from it with nearly undiminished velocity and the kinetic energy transferred when the heavier body weighs 200 times as much as the lighter is only about one fiftieth of the original total In other words the absolute temperature of the gaseous molecule would in a single contact with another 200 times heavier and at rest be reduced 2 per cent

The molecules of a solid moreover are not free and this increases their effective mass so that the actual transfer of energy may well be even less than that just assumed In fact a considerable number of blows are necessary before the temperature of the gaseous molecule is reduced to that of the plate These repeated collisions however follow as a matter of course from the laws governing the diffusion of gases in which process the path of each individual molecule is what has been termed the 'toper's tour' Each moves in short just as if it were a man so inebriated that he falls down at each step he takes and is so lost to all sense of direction that each successive step is as likely to be backward as forward to the right as to the left Under such conditions the probability of his attaining in the course of an hour, any considerable distance from his starting point is extremely small Similarly each gaseous molecule is continually coming into a collision with another and after each collision it darts off on a fresh path the direction of which is absolutely at random The progress of a molecule in any stated direction is therefore exceedingly slow Thus in the case of still air at ordinary temperatures although the molecules are moving with a velocity which averages some 1 300 feet per second, it has been calculated that on the average each only moves from its original position by about ¼ inch per second

Moreover this ¼ inch may lie in any direction Thus if the gas were confined in a tube the molecule which struck the wall at one moment would one second later be ¼ inch away from its starting point but this ¼ inch displacement need not necessarily be in the direction of the center of the tube Hence the molecules which strike the wall at any instant will one second later be on an average only ¼ inch from the wall Actually the distance will be greater than this because the wall forms an absolute limit to the motion of the molecule preventing peregrinations outside Nevertheless the actual displacement will be of the same order as the foregoing so that the random motion of the molecules appears to afford an adequate explanation of the existence of the non conducting film of cold air which experiment has proved to line surfaces absorbing or transmitting heat The same molecule owing to this phenomenon tends to come again and again into contact with the tube in place of making way for a hotter one In these repeated shocks it parts with more and more of its energy losing temperature at each rebound As a loss of temperature corresponds to a decrease of velocity after each contact the molecule becomes less and less able to make its way through the crowd toward the hot center of the tube It would seem therefore that had we to rely on diffusion only for the transmission of heat from a hot gas to a plate the process would be exceedingly slow Fortunately however by establishing a rapid current of gas through the tube the spent molecules can be swept away and replaced by hotter ones The practical effect of this is that the thickness of the spent film is reduced and the hot molecules have to diffuse through a thinner layer in order to reach the wall With very rapid currents a really remarkable rate of heat transmission can be obtained a notable example being the tuyeres of a blast furnace where if our memory serves us heat passes through the metal at a rate which is of the order of 200 000 B T U per square foot per hour A rapid current therefore promotes the transfer of heat although it is common knowledge that boilers worked under heavy forced draught give a low evaporative efficiency In these cases however the rapid current is maintained through the fire as well as through the tubes while the desideratum is the combination of a moderate rate of combustion with a very rapid current through the flues That this combination is possible appears to be proved as well as the added fact that it results in a very notable reduction of the heating surface required for the generation of a given quantity of steam In some special cases the advantage thus gained may offset the drawback of very considerable fan power then necessary, but so far as ordinary boiler practice is concerned it will in all probability turn out that the usual methods of construction and operation cannot with profit be varied to any great degree Tests made with locomotive boilers many years ago have shown that with the same rate of combustion per square foot of firegrate the same evaporation is obtainable with half the tubes blocked as with the whole in effective use but the cost of providing for the additional draught has prevented designers from taking any advantage of this experience In surface condensers on the other hand considerable benefit has resulted from a realization of the importance of the velocity factor in promoting the transfer of heat As a consequence a modern condenser will maintain a high vacuum with less surface than an old-time one —Engineering

THE TERCENTENARY OF THE TELESCOPE.

WHAT THE TELESCOPE HAS ACCOMPLISHED.

BY J. L. E. DREYER.

THE year 1609 is one of the most remarkable epochs in the history of astronomy. In the summer of that year Kepler's book on the motion of Mars was published, in which for the first time the actual orbit of a planet in space was determined, while astronomers had hitherto only been able, with more or less success, to investigate the projection of that orbit on the celestial sphere. In the same year the newly invented telescope was directed to the heavenly bodies, and enabled mankind to form an idea of their constitution, instead of being, as hitherto, reduced to making wild guesses on this subject. But while many years had to pass before Kepler's work became generally recognized (even Galileo never accepted it), the telescope at once became an indispensable tool to astronomers.

Though many attempts have been made to prove that some of the ancient or mediæval philosophers made use of telescopes, it is now generally acknowledged that the telescope was not known to anyone before the year 1608.* On October 2nd of that year Johan Lipperhey, a spectacle maker of Middelburg, submitted to the States General an instrument for seeing at a distance, which he had invented, as was known to the members of the States, and demanded either a patent for thirty years or an annual pension. The States General desired the inventor to produce a binocular telescope, and when he did that, they eventually paid him 900 florins for three instruments of this kind, while the patent was refused on the plea that the invention had already become known to many people. These facts are certain enough, but it is quite possible that Lipperhey may not have been the first to construct telescopes, but that the claims of Zacharias Jansen, another spectacle maker of Middelburg, may be well founded. It appears that this man had invented a compound microscope in 1590. A story was current early in the seventeenth century that some children, while playing with lenses, had found that a weathercock viewed through two of them appeared much enlarged and turned upside down, and that this led to the invention of the telescope. But a telescope which produces an inverted image must have been the so-called astronomical telescope, soon afterward invented by Kepler, which has a convex eye lens, and not the Dutch or Galilean telescope with a concave eye lens, of which the modern opera glass may serve as a specimen. A man who had invented a compound microscope would not be unlikely to possess lenses good enough to produce a fair image of a weathercock, and to have been capable of modifying this accidental discovery by substituting a concave eye lens to make the image upright. Some person is said to have gone to Middelburg to procure a telescope from the spectacle maker there, but to have applied by a mistake to Lipperhey, who thus first heard of the invention.

Whether Lipperhey or Zacharias Jansen was the first to make telescopes will probably never be settled with absolute certainty, but in any case the first telescopes were undoubtedly made in Middelburg. In the introduction to the catalogue of his library (p. xviii) Libri describes a small tract printed at Lyons and dated November 12th, 1608, in which mention is made of "nouvelles lunettes" made by a poor, pious and God-fearing man of "Mildebourg," and the writer states that "even the stars which ordinarily do not appear to our view and our eyes on account of their smallness and the weakness of our vision may be seen by this instrument." From several other contemporary sources we know that knowledge of the new invention spread very rapidly, so that telescopes were not difficult to procure in the spring of 1609, both in the Netherlands and elsewhere. In December, 1608, the States General sent two telescopes made by Lipperhey to King Henry IV. of France; others were publicly offered for sale in Paris about the end of April, 1609, while the news of the invention had reached Venice in December, 1608, and a specimen of the new instrument was brought to Milan in the following May. "The wonderful new toy was so very simple that it is not strange that there was nobody who did not say he invented it," as a contemporary writer tells us. Among these was Galileo, who in August, 1609, on the Campanile of San Marco at Venice exhibited a telescope made with lenses purchased in that city. He claimed to have merely heard that a certain Belgian had presented to Prince Maurice of Nassau a glass by means of which distant objects were seen as clearly as if they were quite near, and that this meagre information sufficed to enable him in a single night to design a telescope. If the information received by Galileo was really as scanty as he says, it is very strange that the man who from it constructed a telescope should shortly afterward in his "Sidereus Nuncius" show that he hardly had grasped the most rudimentary notions as to the passage of rays of light through lenses and the formation of images. He would have done better if he had followed the explanation of the effect of convex and concave lenses given by Kepler in his book on optics published in 1604.*

But even if we cannot give Galileo the credit which he demanded of having re-invented the telescope, and though, as we have seen, others before him had pointed a telescope to the stars, he deserves full credit for having at once grasped the great possibilities offered by the instrument, and for having made the first serious attempt to explore the heavens with it. He did not grind the lenses himself, but made use of such as he could purchase. Judging by the very rough sketches of the lunar surface given in his little book "Sidereus Nuncius" (published in March, 1610), his small telescopes, magnifying from three to thirty diameters, cannot have been very good; still they were sufficient to show that the moon was a body like our earth, having mountains and plains, that the Milky Way really was composed of innumerable stars, and above all they enabled him to discover the four satellites of Jupiter in January, 1610. Continuing his work, he detected in the following autumn the phases of Venus and Mars, and about the same time he became greatly puzzled by the peculiar appearance of Saturn, which planet, instead of showing a round disk, seemed to be triple. This continued to be an unsolved riddle for nearly fifty years, until Huygens by using much improved telescopes showed that it was caused by a detached flat ring round the planet.

In the meantime other observers lost no time in taking up the new study of the heavens. Before the end of 1608 Simon Marius of Anspach procured a telescope with which he found the satellites of Jupiter one day later than Galileo did. He continued for some years to follow their motions with great perseverance and skill, and produced valuable tables of them in his "Mundus Jovialis," published in 1614. Unfortunately he roused the jealousy of Galileo, who accused him of plagiarism, an accusation which up to a few years ago most historians of science were inclined to consider proved, but which has now been thoroughly disproved by a detailed study of the observations of Marius by Oudemans and Bosscha. Marius was also the first to notice the phases of Mercury and the spurious disks of the fixed stars, which the imperfect telescopes of Galileo had failed to show. Even to the sun was the new instrument directed. Galileo says he saw the sunspots in the summer of 1610, but he does not seem to have taken any interest in them at first, and did not as usual announce the discovery either openly or through an anagram. Thus Johann Fabricius was the first to publish the discovery of sunspots, early in 1611, though Galileo made up for his hesitation by systematic observations and by being the first to recognize that the spots are formations at the surface of the sun itself and not bodies moving round the sun, as Scheiner, the third and most assiduous observer of sunspots, for a long time maintained.

The Dutch or Galilean telescope did not for long remain the only telescope used by astronomers. Already in 1611 Kepler published his "Dioptrice," in which he clearly showed the effect of combining various lenses and the advantages of the "astronomical telescope," in which the real image of the object is formed by the object glass at the focus of the latter, which is viewed through a magnifying convex eye lens. A year or two later Scheiner, and following him Fontana, actually constructed and made use of telescopes of this kind, while the inconvenience of the inverted image produced by them was obviated by the introduction of an additional lens in the "terrestrial telescope" to reinvert the image formed by the object glass. The importance of the real image, which allows a wire or a wire-cross placed at the focus to be seen through the eye piece as sharply as and coinciding with the image, was recognized about 1640 by William Gascoigne, who applied a telescope to a quadrant for measuring altitudes, an application which had been suggested in 1634 by the French astrologer Morin, who however only possessed a Galilean telescope. Outside England Gascoigne's idea probably remained unknown, and it was not until 1667 that Auzout and Picard applied telescopes to measuring instruments, and thereby immensely increased the accuracy attainable in astronomical observations.

The importance of the invention of the telescope for the advancement of astronomy is not to be measured only by the insight it gave into the nature of the heavenly bodies and the aid it rendered in following their movements more accurately. It also rendered an important service by making the Copernican system appear more natural and reasonable in the eyes of every unprejudiced thinker. Hitherto this system had probably to most people appeared to be nothing but a new way of "saving the phenomena" (to use an expression of the ancients), that is, a new method of calculating the motions of the planets, which anyone might use, whether he believed in the reality of the earth's motion or not. Two circumstances had contributed to give an appearance of unreality to the new system: first, the numerous epicycles which Copernicus had been compelled, like the ancients, to use in his planetary theories (because he did not know the first two of Kepler's laws, and therefore had to confine himself to combinations of circles); and secondly, the spurious preface which, without the knowledge of Copernicus, had been added to his book, in which the system was spoken of as a mere hypothesis which need not be supposed to be true. To assume the earth to be one of the planets was also a difficult thing, so long as absolutely nothing was known about the other planets. As to the moon, the ancients had supposed that it must be a body rather like the earth, and the telescope only confirmed this hypothesis. But adversaries of the Copernican system had always asked how the earth could carry the moon along with it during the annual motion round the sun, or why the moon alone should form an exception to the general rule by moving round a planet instead of round the sun. Now Galileo could point to the undeniable fact that Jupiter during its orbital motion carried four satellites or moons along with it. The discovery of the phases of Venus and Mercury deprived opponents of Copernicus of another favorite weapon, for they had been wont to proclaim that if Venus moved round the sun it ought to show phases like the moon. Again, the discovery of sunspots, objects of a temporary nature, supplied a very striking proof that the Aristotelian doctrine of the immutability of all things celestial would have to be given up. While the analogy between the earth and the planets grew stronger every day, it was also of great importance that the fixed stars in the telescope appeared as mere luminous points, so that the apparent diameters of several minutes attributed to them by all previous observers were proved to have no existence. This put an end to the serious objection raised by Tycho Brahe, the greatest practical astronomer since Hipparchus, that a star having no annual parallax and yet having a considerable apparent diameter must be incredibly large.

As it were in a twinkling of an eye, the whole aspect of the universe had been changed by the invention of the telescope. That this was felt in some way even by determined opponents of the idea of the earth's motion may be seen from the statement made by Clavius, the chronologist, in 1611, that astronomers would have to look out for a system which would agree with the new discoveries, as the old one would not serve them any longer. The question could no longer be: "Do you believe in the earth's motion?" It could now only be whether the arguments in favor of this motion were becoming so irresistible that the safest thing to do for its opponents would be to proclaim the doctrine to be heretical. This was [illegible] done little more than seven years after the invention of the telescope.—Nature.

The pressure per square inch that water exerts at each foot of depth is expressed in the case of sea water weighing 64 pounds per cubic foot by the equation

$p = 0.4444y + 0.000000$ [illegible] y, in which p represents the pressure and y the depth in feet beneath the free surface.

In the case of fresh water weighing [illegible] pounds per cubic foot, the results given by the above equation would require to be multiplied by [illegible], and for any other density the resulting pressure will be as many sixty-fourths of the pressures computed from the above equation as there are pounds of weight to the cubic foot.

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* See in particular Thomas Henri Martin's Paper "Sur des Instruments d'Optique faussement attribués aux Anciens par quelques Savants modernes," in Boncompagni's Bullettino, iv., 1871.

* "Opera ed. Frisch," i., p. 68.

THE EFFECT OF TIDES ON THE EARTH'S CRUST.

THE WORK OF DR. HECKER AT POTSDAM.

BY CH. LALLEMAND.

As the different parts of the earth are unequally distant from the moon they are unequally attracted by that satellite. The attraction is greater in the hemisphere turned toward the moon and less in the opposite hemisphere than it is at the earth's center. The difference in attraction produces the effect of a small disturbing force which causes a plumb line to deviate slightly toward the moon in the first named hemisphere and away from the moon in the opposite hemisphere and which [illegible] the surface of the ocean in two protuberances around the point directly beneath the moon and the antipodal point (Fig. 1).

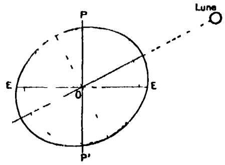


Fig. 1.—Double Protuberance of the Surface of the Ocean Caused by the Moon's Attraction.

[illegible]

In consequence of the apparent revolution of the moon around the earth in [illegible] hours and [illegible] minutes these protuberances travel in the same period producing at every point of the ocean two daily tides which are of unequal heights except when the moon is at the equator. The sun acts in a similar manner but as its greater mass does not compensate for its greater distance the solar tides are only about half as high as the lunar tides. The two effects are added together at new and full moon when the earth, sun and moon are nearly in the same straight line but at the moon's quarters or quadratures the elevation caused by the moon is half neutralized by the depression due to the sun.

Tides are not confined to the liquid mass of the oceans. The earth itself is subject to the same influences and experiences similar deformations which however are not easily observed.

No movement can be detected without a fixed point of reference. For the tides of the ocean such points are furnished by the coasts and the tides can be observed only on the coasts. If the earth were entirely covered by water and men lived on floating islands the existence of tides would never have been suspected. This is exactly our position in relation to tidal movement of the earth's crust. We have no fixed points of reference and are compelled to attack the problem by a different method.

The deviation of a plumb line by the moon's attraction has already been mentioned. The sun produces a similar deviation and the combined effect of the two luminaries varies with their positions causing the plumb bob to describe a very small closed curve. The masses of the earth, moon and sun and their relative positions at every instant being known, the corresponding deviations and the curve described by the plumb bob can be calculated. If the earth were perfectly rigid the curve thus computed would coincide with the curve actually described while if the earth were entirely liquid its surface would be normal to the varying direction of the plumb line at every point and no motion of the bob with reference to the surface could be detected.

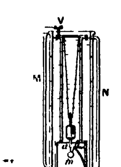


Fig. 2

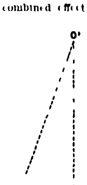


Fig. 3

Fig. 2.—Sir G. H. Darwin's Vertical Pendulum.

[illegible]

Fig. 3.—Diagram of Horizontal Pendulum.

As the crust of the earth is not perfectly rigid it becomes slightly deformed under the influence of tidal action and consequently the deviation of the plumb line relatively to the earth's surface is less than the theoretical deviation computed on the assumption of perfect rigidity. If the actual deviation could be measured it would afford means of estimating both the extent of the tidal displacement and the coefficient of rigidity.

This measurement is attended by two serious difficulties. The deviation is very small, less than 0.01 inch, so that the terminal point of a pendulum 40 inches long could never pass outside a circle 1/20,000 inch in diameter. Furthermore the superficial strata of the crust are warped by the heat of the sun and this deformation produces an apparent deviation of the pendulum in a direction opposite to the deviation by solar attraction. The latter is only about 0.005 inch but the thermal deviation is 100 times as great (0.5 inch) at the earth's surface and 10 times as great (0.0[illegible] inch) at a depth of 82 feet.

Though it would appear impossible to separate the two effects the task has been attempted within the last [illegible] years by several eminent scientists. D'Abbadie, Zöllner, Bouquet de la Grye, Lord Kelvin, Sir George Darwin (Fig. 2) and Wolf have successively but in vain devised very delicate and sensitive apparatus for the measurement of the deviations of the pendulum.

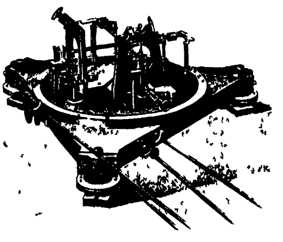


Fig. 4.—Hecker's Crossed Horizontal Pendulums.

Within the last fifteen years more encouraging results have been obtained by Dr. Rebeur Paschwitz, Kortazzi and Schweyder by the employment of the horizontal pendulum.

In order to measure with a vertical pendulum of the ordinary type deviations as small as those here considered it would be necessary to use a pendulum of enormous length. The same result can be attained by placing the axis of rotation of an ordinary pendulum (S S, Fig. 3) in a nearly vertical position. The pendulum is thus made equivalent to a very long vertical pendulum O' C oscillating about the point O' at the intersection of the axis of suspension S S and the vertical through the center of the bob C. This length can be determined by causing the pendulum to oscillate with its axis successively in the inclined and the usual position. The effective lengths are proportional to the squares of the periods of oscillation in the two portions and the angular deviations are in the inverse ration. From the deviation of the horizontal pendulum the deviation of the plumb line can be easily deduced.

The most remarkable experiments which have been made with this instrument are those which were conducted by Dr. Hecker at Potsdam between 1902 and 1909 with an apparatus (Fig. 4) comprising two round horizontal pendulums installed in an underground chamber of constant temperature and humidity 82 feet below the surface. The images of a luminous point reflected by two small mirrors attached to the pendulums were continuously photographed upon a distant cylinder which was covered with sensitive paper and turned by clockwork. This combination of mechanical and optical enlargement made each horizontal pendulum equivalent to an ordinary pendulum as long as the height of Mount Blanc. The observations were combined so as to determine the solar and lunar effects separately. The solar effect shown in Fig. 5 is chiefly thermal, the maximum and minimum deviations (±0.025 sec.) occurring about 6 o'clock morning and evening simultaneously with the maximum and minimum temperatures of underground rooms. The much larger curve of lunar deviation is shown in Fig. 6 surrounded by the still larger ellipse which the front of the pendulum would describe if the earth were perfectly rigid. The mean semi-diurnal lunar deviations along and perpendicular to the meridian are compared in the following table:

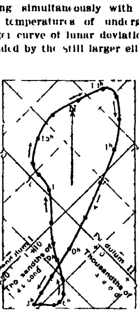


Fig. 5.—Mean Apparent Daily Movement of Pendulum Point Caused by the Sun.

Direction deviation in thousandths of a second of arc.

	Theoretical	Observed	Ratio
East and West	±10	±7.7	0.77
North and South	±8	±3	0.37
Mean Ratio			0.55

The decrease of deviation caused by the elasticity of the earth's crust is twice as great along the meridian as along the parallel of latitude. Hence according to a formula found by Schweyder the rigidity in the latter direction is eight times that in the former.

New measurements made on other continents would show whether this difference is due to the apparatus or its installation, to the structure of the earth's crust at Potsdam, or to the general tetrahedral deformation of the globe which might be expected to make the rigidity greater in the direction of the European-Asiatic edge of the tetrahedron which passes near Potsdam than at right angles to that edge.

In earlier experiments with the horizontal pendulum the observed deviations were equal to 2/3 the calculated deviations. According to Lord Kelvin, Sir George Darwin and Schweyder the oceanic tides of long period (monthly and semi-monthly) likewise have only 2/3 the theoretical amplitude calculated for a rigid globe.

The earth's poles are also subject to an oscillation of a few yards each way which cause the latitude of every point of the earth's surface to vary to the same extent. If the earth were absolutely rigid the period of this oscillation would be 305 days but the elasticity of the earth increases the mean period to 436 days. I have shown that this increase in the period of oscillation of the poles corresponds to a reduction of the height of ocean tides to 7/10 its theoretical value.

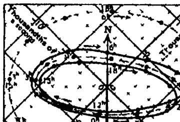


Fig. 6.—Mean Apparent Daily Movement of Pendulum Point Caused by the Moon.

— — observed movement
— mean semi-diurnal movement
theoretical semi-diurnal movement

Hence the value 2/3 for the coefficient of reduction may be regarded as nearly correct The corresponding value for the rigidity of the earth is greater than that of copper and 5/6 that of steel

In these conditions the tides of the earth's crust would be as great as those of the ocean At the equator the amplitude of the lunar tide would be about 13½ inches and that of the solar tide 6 inches which would produce combined tides of 19½ inches at equinoctial new and full moons and of 7½ inches at equinoctial quadratures In the latitude of Bordeaux these earth tides would be diminished one half and at the poles they would be reduced to nothing—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature

INSECTS VS. FIRES.

TWO METHODS OF FOREST DESTRUCTION.

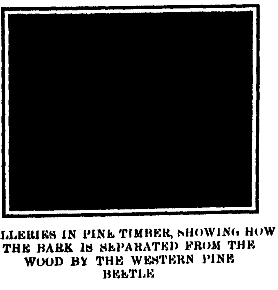
BY CHARLES RICHARDS DODGE

Some startling statements have been made recently by Dr A D Hopkins of the National Bureau of Entomology in relation to the money loss to the country from the devastation of forest insects We hear so much in the present day regarding the rapid deforesting of the country for commercial ends in the production of the many forms of lumber in the manufacture of wood pulp etc and also through the agency of forest fires that the damage caused by a few species of insignificant beetles is almost wholly lost sight of Dr Hopkins figures throw new light on the subject showing as they do that the losses from the attacks of insects are of far more serious consideration than the destruction from the forest fires which occur in every section of the country

Recalling a recent statement that at the present rate of cutting all of the spruce forests will have been ground into pulp wood in another decade it is an interesting fact that forest fires wipe out in a single year the equivalent of a two years cut of pulp wood The cut for the year 190[illegible] cleared an area of something like 43[illegible] 000 acres of forest growth the product being valued by the acre at $2 000 000 Mr T Cleveland of the United States Forest Service estimates that on the average since 1870 forest fires have cost the country annually $50 000 000 in the value of the timber destroyed For many years Dr Hopkins has made forest insects his special study and from investigations carried on by himself or his assistants he estimates that the average annual loss to the whole country from forest destruction by insects amounts to a matter of $62 000 000

The estimate of the area and stand of the present forests of the United States as given in a recent publication of the Forest Service is two trillion five hundred billion feet (2 500 000 000 000) board measure The average stumpage value has been stated at $2 50 per thousand feet board measure making a total value of the standing merchantable timber of $6 2[illegible]0 000 000 In considering the amount of standing merchantable timber killed by insects and the amount of standing timber living dying or dead which has been reduced in quantity and value through their agency during a ten year period Dr Hopkins estimates that such timber represents an equivalent of more than 10 per cent of the quantity and stumpage value of the total forest area of the country For the ten year period the amount chargeable to insects would be $625 000 000 or an average of $62 500 000 annually

A species of insect known as the Black Hills beetle killed approximately 1 000 000 000 feet board measure of timber during a period of ten years which at $2 50 per thousand feet would amount to an annual loss of $250 000 This is merely one example of very destructive depredation by a single species of bark beetle in a single national forest of a million and a quarter acres The average losses from fires on the national forests of the United States from 1905 to 1908, inclusive, are estimated by Mr Cleveland to amount to but $165 000 annually Even a portion of this fire loss is indirectly chargeable to insects as they contribute to such losses by furnishing a ready means for the spread of fires over large areas which otherwise might have been confined within narrow limits In many cases it has been found that after insects have killed the timber over extensive areas the standing and fallen dead trees have furnished fuel for great forest fires which have not only destroyed or charred the dead timber but killed the living timber and reproduction and swept on into adjacent areas of healthy timber Abundant evidence has been found in recent investigations to indicate that some of the vast denuded areas in the Rocky Mountains and other sections of the country are primarily due to widespread devastations of insects and that subsequent fires destroyed the timber and prevented reproduction It is also evident that a considerable percentage of dead timber and especially that found in coniferous forest regions generally believed to have been fire killed is a result of primary attack by insects While a vast amount of timber has been killed outright by forest fire in almost every case observed insects have contributed to a greater or less extent to the death of recently fire injured trees which might otherwise have recovered and especially to the rapid deterioration of the wood of a large percentage of killed trees



GALLERIES IN PINE TIMBER, SHOWING HOW THE BARK IS SEPARATED FROM THE WOOD BY THE WESTERN PINE BEETLE

INSECT KILLED PINE TREES

Two dead pine trees are shown standing in what was formerly a large northeastern forest area Seventeen years ago the section was visited by a sudden invasion of bark beetles which killed a high percentage of the trees Up to that time forest fires had done comparatively little damage and were small affairs but since the attack and subsequent death of the trees this forest area has been visited by several very destructive and extensive forest fires The tree in the left of the picture gives evidence of having been struck by lightning and the trunk partly burned This is an example out of many cases that could be cited which furnishes evidence that lightning striking a dry insect killed tree may start a disastrous fire And there is every reason to believe that many fires supposed to have been started by man's carelessness are due to lightning striking a dry dead and insect ridden trunk which leaping into flame starts a conflagration which burns both dead and living trees over a vast area In the statistics of forest fires no one will ever know how many millions of feet of insect killed timber is included

Regarding the durability of standing timber killed by insects some interesting statements are made which present another phase of the question of losses by insect depredation As a general proposition it may be said that timber killed by insects and fire would be available for utilization for many years were it not for injury through the secondary attack of wood boring insects and the destruction of insect killed timber by forest fires As an example it may be stated that larch trees which evidently died as a result of defoliation by the larch worm between 1881 and 188[illegible] were sound enough in 1908 to be utilized for railroad ties and other purposes In this instance the killed timber had escaped subsequent injury from wood boring insects and from fire

So far only damage to standing or living timber has been considered Unfortunately the destruction does not cease here for when we take into account the aggregate loss to the dealers in the sawn lumber and to the manufacturers of the finished product to the trade and to the consumer the total will be increased many millions of dollars beyond the estimated losses from trees killed in the forests Hardwood lumber of all kinds rough handles wagon stock etc made partially or entirely of sapwood are often reduced in value from 10 to 40 per cent by a class of insects known as powder post beetles the sapwood of hickory ash and oak being most liable to attack During the past few years the reported losses from this source of injury on account of reduced values might range from [illegible] to 10 per cent Tanbark is quite liable to attacks of insects and in some tanyards [illegible] per cent of the [illegible] year old bark is destroyed In one West Virginia tannery more than $[illegible] worth of bark was destroyed in this manner Such finished products as ax and other tool handles wagon stock and machinery stock—especially manufactures from hickory and ash held by the trade or stored often in vast quantities by the army and navy are subject to more or less serious injury the extent of which if stated in dollars and cents would make a tremendous showing When once attacked material of this kind is usually rendered worthless for the purposes indicated and must therefore be replaced by new material It is estimated that the losses upon such materials have amounted to from 10 to [illegible] per cent

Construction timber and other woodwork in houses in bridges and like structures as well as railroad ties telegraph poles fence posts mine props etc which are frequently injured by woodboring larvae black and white ants carpenter bees and powder post beetles are sometimes reduced in efficiency from 10 to 100 per cent

While forest trees are often injured or killed outright by defoliation due to a sudden invasion of some leaf eating species by far the most destructive agency has been found to be certain species of bark boring beetles which literally girdle the living trees by boring galleries and mines in every direction around the main trunks On all forests there will be more or less damage from this source of injury but it frequently happens that certain species of insects appear in such vast numbers as to become an invading army of destruction In 18[illegible] such an insect invasion of forests occurred extending from West Virginia through Maryland and Virginia and into North Carolina on the south and into Pennsylvania on the north covering an area of [illegible]000 square miles In this instance the enemy was the southern pine beetle and its operations were conducted against pine and spruce trees chiefly although shade and ornamental trees also suffered greatly In portions of this area all of the pines and spruces growing upon thousands of acres

BARK SEPARATED FROM THE WOOD BY GALLERIES OF THE SOUTHERN PINE BEETLE were killed. Fig. [illegible] illustrates how the trees are killed.

Almost as destructive a species is the eastern spruce beetle, which works in the forests of New York, New England and Southeastern Canada. From time to time there have been outbreaks of this species, resulting in the destruction in the aggregate of many billions of feet board measure of the finest lumber and the devastation of thousands of acres of forest lands. In the Rocky Mountain region outbreaks of the Engelmann spruce beetle have killed in some sections [illegible] per cent of the timber of merchantable size. Still another exceedingly destructive species is the Black Hills beetle, which during the past ten years has destroyed a large percentage of merchantable timber in the Black Hills National Forest of South Dakota, as previously referred to. Two other species of pine beetle operate still farther west in the Cascade range and southward through the Sierra Nevadas. In one locality in Northeast Oregon it is estimated that [illegible] per cent of the timber in a dense stand of lodgepole pine, covering an area of 100,000 acres, has been killed within three years by a [illegible] beetle known as the mountain pine beetle, and throughout the sugar pine districts of Oregon and California a considerable percentage of the best trees is dead. See Fig. 1.

The Douglas fir beetle is another very destructive species, while other near relatives depredate on the pines of New Mexico and Arizona. All of the above species are members of the genus Dendroctonus, which represents the most destructive enemies of the principal coniferous tree species of American forests, and at the same time the easiest to control.

In the Eastern United States the hickory bark beetle (a species of Scolytus) causes great destruction of hickory timber throughout the Northern tier of States from Wisconsin to Vermont and southward through the Atlantic States to Georgia.

From [illegible] to 100 per cent of the larch trees growing over vast areas of the Northeastern United States have been killed by defoliation since 1880 in outbreaks of the larch worm, the losses running into billions of feet of merchantable sized lumber.

These are a small part of the insect enemies of forest trees, for the list in its entirety is a long one, and all kinds of trees seem to have one or more destructive insect enemies. The many kinds of oak, chestnut, beech, whitewood, poplar, elm, locust, etc., all have been attacked at times, or in a lesser degree at all times, and in many cases, even when a tree has not been killed outright, its quality as hardwood lumber has been seriously impaired to an extent frequently amounting to a reduction of value from 25 to [illegible] per cent.

The question may be asked if a tree dead from the attacks of bark beetles has any value as timber. As an answer it may be said that timber killed by bark borers is not necessarily rendered useless for lumber, as some species of trees might be available commercially during periods of from one to twenty years were it not for the fact that such dead trees are further attacked by other insects, species of wood-boring beetles which extend their burrows in all directions through sound sapwood and heartwood alike, thereby hastening deterioration and decay. Thus dead timber which otherwise would be commercially valuable suffers injury and deterioration from 25 to 100 per cent. An example of the destructive work of this class of insects may be cited in the case of areas of cypress trees in a Southern State deadened by the lumbermen and left standing until sufficiently dry to be floated. Such trees at certain seasons have been attacked by Ambrosia beetles and pin-hole borers, and the timber damaged to the extent of a reduction in value from [illegible] to 7[illegible] per cent. In some instances millions of feet of timber have been damaged in this manner.

The same class of borers will attack freshly sawed hardwood placed in close piles during warm, damp weather, from June to September. In one instance a lot of several thousand feet of highest grade mahogany timber sawn from imported round logs and piled with lumber sticks between the tiers of plank was attacked, and within a few weeks the beetles had entered the wood to such an extent that its value was impaired one-half. Heavy 2-inch to 3-inch stuff is liable to attack even when loosely piled, and heavy square timber may be badly damaged, especially when the bark has been left on the edges.

It will be seen by the foregoing that whatever system of conservation may be adopted in regard to our remaining forest areas, two agencies must be recognized which are bound to annually reduce these areas without a money equivalent, and it should be recognized also that the money loss to the country from either cause is far too large to be ignored. This leads to the question of insect control. That the destruction of forest trees, lumber and manufactured products by insects can be controlled with little or no ultimate cost over that involved in good forest management and business methods has been demonstrated in recent years through the extensive investigations and practical applications of those who have made the subject their especial study. It is stated that if the information now available through publications of the Department of Agriculture and through direct correspondence with its experts is properly utilized in the future, it will result in the prevention of an equivalent of at least 30 per cent of the estimated annual destruction from insect attacks in recent years, and conserve the present forest areas to that extent. How to control these foes of the forest is too long a story for these pages. Those who are interested in the matter, therefore, will do well to communicate with the Department of Agriculture direct.

ROOSEVELT'S TROPHIES.

STRANGE ANIMALS SHOT BY THE EX-PRESIDENT.

The many specimens of skins and skulls that have come to the United States National Museum from the Smithsonian African Expedition under Col. Theodore Roosevelt have brought to light some names of animals that frequently fall in [illegible] to identify the animal. Of this character are klipspringer, topi, hartebeest, wildebeest, gazelle, impalla, dikdik, otocyon and perhaps cony.

The klipspringer, which is called klipspringer by the Hottentots and klipbok by the Boers, is a small antelope that is widely distributed through South Africa. It may be found up the east coast through the province of Mozambique, and is plentiful in Northern Zambesi, but in Cape Colony it is not as numerous as formerly. It cannot run very quickly on level ground, but when climbing a hill its marvelous agility is apparent, for it will race up the smooth face of slippery rocks so steep that no other animal other than a baboon could find a footing there. Its fondness for a rocky country has led to its being called the chamois of Africa. Klipspringer stalking in Africa is a very pretty sport, affording healthful exercise, frequently amid charming scenery.

The topi, according to some writers, is nominally a hartbeest, that is, it is something like an antelope and yet much heavier, having to a certain extent characteristics that ally it to the family that includes the bovine species. It is a good-sized beast and sturdily built, and has a beautifully hued skin of purplish tint with a bloom on its coat which seems to change color in different lights like shot silk. Its distribution is [illegible]. It is found near the coast and also far in the interior, yet there are wide regions where it is unknown. The flesh of the topi is excellent, furnishing the best meat for eating in some parts of Central Africa.

The hartebeests are large antelopes that go about in herds and are very swift. There are many varieties of these animals, although they are usually classified as hartbeests proper, bastard hartebeests and gnus. Among the bastard hartbeests are the topi already mentioned, the korrigum and the tiang. The hartebeests are more or less ungainly looking ruminants of comparatively large size, with naked muzzle, very small gland in the face below the eyes, and large valved nostrils, of which the lower lids are covered with a number of short bristly hairs. They have long tufted or hairy tails and have peculiarly angled horns set at the extreme top of a very long face. In color they are either uniformly brown or similarly colored with the addition of blackish or purplish patches on the face, shoulders, hind quarters, and lower portions of the limbs. They are sometimes domesticated, but usually are hunted for their flesh, which resembles beef.

The wildebeest is better known as the gnu, and of it there are the brindled species and the white-tailed gnu, with three distinct varieties of the first species. Wildebeests are described as grotesque looking ruminants with disproportionately large heads, distinguished from other genera of hartbeests by the tufts of hair on their face, their manes, deep necks, very broad muzzles, doubly curved smooth horns and long horse-like tails. Their general color varies from gray to dark brown, with or without transverse stripes, the long hair of the mane and tail being either black or white. From their peculiar appearance they have often been called horned horses.

Gazelle is the name of a group of graceful little antelopes which are commonly known as gazelles, from the Arabic name of one of the species. They are found in the more open districts of Africa and are divided into about fifteen distinct species. Generally the color is sandy above and white below, and in all African species the face is marked with longitudinal dark and light streaks. Tufts of hair are usually developed on the knees, and the tail is of medium length in the African species.

Impallas, or sometimes simply pallas, is the name given to certain antelopes. There are two African species known to science, the common impalla and the Angolan impalla. Their general color is bright reddish brown, but paler along the lower part of the sides. The horns of the impallas are particularly graceful. They extend convex below and concave above, spreading evenly. They are described as most graceful and agile creatures. They display great activity when alarmed, flying through the scrub and bounding high over bushes one after another as the herd follows its leader in his headlong course, or if surprised at close quarters in thick cover the bush becomes suddenly alive with them, several often being in the air simultaneously in their first bewildered fright.

Dikdik is the name given to a curious group of little antelopes which may be distinguished from all other forms by the more or less marked elongation of the muzzle, which is almost entirely covered with hair, and the presence of a tuft of long hair on the crown of the head. The tail is so short as to be almost rudimentary, and the lateral hoofs are very small. Seven distinct species are known. They stand about 15 inches in height.

The otocyon is a small carnivorous animal quite like a fox. There are several species of this animal, one of which, called otocyon virgatus, is generally of a bright buff color and is new to science. Its skull is said to closely resemble that of the gray fox of our native fauna.

The many kinds of boks, such as the blesbok, bontebok, rhebok and others, are almost all antelopes or deer-like animals that have been so named by the Boers. Of similar characters are the bucks, such as the bushbuck, reedbuck, waterbuck, etc., the name of which suggests English origin.

The cony is a small animal with fleshy pads in its toes, by means of which it can climb with great agility among rocks and in large trees. Although comparatively small, being only about the size of a woodchuck, nevertheless it has much the same structure as such very large animals as the rhinoceros. The cony is of interest on account of having been frequently mentioned in the Bible. It occurs only in Syria and certain parts of Africa, but no species of it is found in the United States.

THE WORLD'S PRODUCTION OF NICKEL

The world's production of nickel declined from 14,100 metric tons in 1907 to 12,800 metric tons in 1908. The production of nickel is confined almost entirely to the United States, Canada, Great Britain, Germany and France. The United States and Canada furnish nearly half the total quantity, and their production has increased since 1900 more rapidly than that of Europe, as is shown in the following table, in which the quantities produced in the various countries are given in metric tons:

	Great Britain	Germany	France	United States and Canada	Total
1900	1500	1400	1700	3000	7526
1901	1800	1700	1800	3600	8810
1902	1300	1600	1100	4700	8739
1903	1700	1600	1500	5100	9850
1904	2200	2000	1800	6000	12000
1905	3100	2700	2200	4500	12500
1906	3200	2800	1800	6500	14300
1907	3200	2600	1800	6500	14100
1908	2800	2600	1400	6000	12800

Nickel has no market in the strict sense of the word. Its price depends on individual agreement and fluctuates greatly. The approximate average price per pound declined from about 48 cents in 1893 to 32 cents in 1896, since which date it has fluctuated between 32 and 37 cents.

A subway for Vienna is projected, according to the Zeitschrift des Oesterreichischen Ingenieur Vereines. This new system, which if built will be the first subway in the city, is designed to run in two lines, crossing each other at right angles in the center of the city. The project at present calls for municipal ownership and the construction of a large power plant, from which light and power are to be sold.

PHOTOGRAPHY SCIENTIFICALLY INTERPRETED.

CHEMICAL AND PHYSICAL CONSIDERATIONS.

BY DR. LUDWIG W. GUENTHER.

EVERYBODY who has even once taken a photograph or printed a negative has in so doing perhaps unconsciously brought into play a series of photochemical laws At his first attempts he no doubt experienced some anxiety about having made the proper exposure for this is of course the alpha and omega of all photographic processes Too short an exposure will cause some details to be missed too long an exposure will destroy contrasts It is a matter of common knowledge that the negative must be developed and fixed in order to bring out and render permanent the invisible latent image In this development lies the immense value of Daguerre's and Talbot's invention with which they surprised the world seventy years ago (1839) and in this point is found the radical superiority of their method over all previous experiments in which the copying or printing of pictures had been accomplished but never direct exposure in a camera Before Daguerre and Talbot exposure was continued until the image was visible in all its details and this of course required infinitely more time than when the work of light was assisted or completed by a chemical reaction The original discoverer of the fact that silver salts are sensitive to light was a German Professor Schulze of Halle

The science dealing with the chemical reactions due to the influence of light is called photochemistry We are always performing photochemical operations when we are doing photographic work only in that case the scientific phase is less prominent than the artistic phase of picture making science becomes the handmaid of practical work This ought not to be so for without science we should not have attained the present perfection

When we make a positive from a negative by means of a printing out paper such as aristo (gelatine) paper collodion paper or albumen paper we can follow the process readily sooner or later we reach the moment when we say That will do and remove the printing frame from the light This enough indicates the maximum of the process the desired photochemical effect What does it depend on? On light alone? No It also depends on the length of exposure Intuitively we use a shorter exposure if the light is strong and a longer one if the light is weak that is to say the length of exposure will depend on the strength (intensity) of the light We thus obtain the law of photochemical reciprocity discovered by Bunsen and Roscoe about the middle of the last century and enunciated as follows .The photochemical effect E is in direct ratio to the product of light intensity I multiplied by length of exposure t that is $E = It$ From this law it follows that if we have a constant source of light and desire to print negatives of different density we must expose the longer the denser the negative happens to be or conversely if prints of the same quality are desired after a constant length of exposure the denser negative will have to be exposed to light of greater intensity This is a condition the busy photographer will often have to face He will meet it either by placing the denser negatives nearer to the lamp or other source of light or he may put one or more layers of tissue paper over the thinner negatives

It is not difficult to observe this rule when using printing out paper which as stated above allows the progress of printing to be watched It is less easy to do this with paper for printing by gas light a developing paper the sensitiveness of which is low enough to allow it to be handled by the light of a gas burner or kerosene lamp as long as the paper is not brought too near the light the greatest difficulty of course is experienced with the highly sensitive dry plates All sorts of apparatus have been recommended for accurately establishing the equilibrium between light intensity and length of exposure the old infallible actinometer the new ones devised by Hyde and Plaubel the Agfa exposure table and Staeble's exposure table they all serve this purpose without however relieving the amateur of the final delicate estimating

The relations between light intensity and length of exposure have found a practical application in a case where the keenest eye would have failed even when assisted by the best instruments in astronomy By substituting a camera for the eye piece of one of our modern giant telescopes even very faint stars may be photographed under a prolonged exposure In this work a leading part has been taken by the Heidelberg Astrophysical Institute, under the direction of Professor Max Wolf

There is, however, a lower limit of light intensity below which even the longest exposure will have no effect This limit is called the critical value of the sensitive plate

For practical purposes it is of the utmost importance to know the sensitiveness of a plate or more properly speaking its maximum sensitiveness This is the function of sensitometry a science also founded by Bunsen and Roscoe and developed to its modern condition by Vogel Eder Warnerke and Scheiner The sensitive plate is exposed for a predetermined length of time in streaks or stripes the sensitive layer being covered with a glass plate having squares differing as to perviousness to light and suitably numbered The simplest way of producing these squares is to cut out of tissue paper strips of the same width but different length and superposing these with one end in registry so that the other end will overlap in stepwise fashion The last (highest) number just faintly visible after strong development is the degree of sensitiveness in units of the particular scale adopted such as Scheiner's or Warnerke's This kind of sensitometry is successfully applicable only to highly sensitive plates and to diapositive plates but not to orthochromatic plates With the latter it is necessary to resort to a supplementary spectrophotographic determination

Working with highly sensitive plates is especially difficult because the allowable deviation from the absolutely correct length of exposure becomes less and less as sensitiveness is increased A most reliable plate for amateurs where snapshots are not intended is the silver eosin plate of Vogel and Obernetter manufactured by Otto Perutz of Munich

This silver eosin plate is the direct result of a very remarkable invention of H W Vogel which culminates in the possibility of rendering silver bromid (the sensitive material of dry plates) sensitive to all light rays of the spectrum that is to say orthochromatic whereas hitherto silver bromid would be affected only by the blue violet and ultra violet rays The rays were formerly known as chemical rays and are still referred to as such sometimes but improperly The statement of this invention leads us to another photochemical law the so called law of absorption first perceived by Grothuss and definitely formulated by Draper Of what avail is the very strongest exposure if the light rays are not absorbed so as to exert a chemical action Who knows what bodies sensitive to light may yet be discovered if we only learn to make them sensitive to light to sensitize them optically? Sensitizing is accomplished by dipping the plate in dilute solutions of coloring matters for instance eosin

In all photochemical processes there must be work done by light it must vanish as such and reappear in a different form for instance as heat electricity or chemical decomposition In the last named case we are dealing with the so called photochemical extinction (extinguishing)

Another law is that of photochemical induction It requires a certain amount of preliminary or inductive exposure before the starting of the chemical process As a matter of fact if a dry plate is exposed for a very short time to diffuse light or to red light its sensitiveness is increased materially Incidentally it may be noted that a similar effect may be produced by the action of heat

It is not immaterial however whether we employ a single long exposure or a series of very short exposures of an aggregate length equal to the long exposure The result will not be the same but in the later case (of the intermittent exposure) underexposure will be observed and it would seem as if the plate after each light impulse found time to recover and to go back toward its original condition This return of the plate was ascertained after a lapse of several years even with plates which had received the proper length of exposure

The developing process itself which brings to view the latent image the initially invisible light impression really leads to the same final result as a long exposure continued until the image is fully visible in one case as in the other silver that is dark silver is precipitated from the white silver chlorid or silver bromid Chlorin or bromin escapes as a gas In the printing out process and in developing as well chlorin and bromin combine chemically yet there is a material difference between the two processes The printing out process may be considered a typical case of a reaction proceeding in the presence of light the developing process on the other hand is a typical case of reaction proceeding in the dark With the aid of development we are able to imitate artificially even under complete exclusion of light the light process of printing out and its products

The relation between reaction in the presence of light and reaction proceeding in the dark is particularly instructive in cases where the process is reversible or cyclic Suppose we take say silver chlorid and put equal quantities in glass vessels of equal volumes exhaust the air from some of the vessels to different degrees and fill others with air under various pressures carefully seal both kinds of vessels and expose them to light for the same length of time simultaneously with other unsealed vessels and some sealed under atmospheric pressure the darkening of the silver chlorid will be a measure for its chemical decomposition by the action of light or in other words for the work done by the light We shall find that the substances enclosed in exhausted vessels have become darkest the more so the greater the vacuum With the substance held under pressure the darkening decreases with the increase of pressure The unsealed vessels we shall consider standard vessel If then we bring all the vessels back into the dark we shall find after some time that in some cases the darkening effect has disappeared partly the substances sealed under increased pressure have again become quite white while those under a vacuum have only become somewhat lighter in color The substances in the open vessels have remained unaltered (dark) for in this case the liberated chlorin has escaped into the surrounding air and the process is no longer reversible

How shall we explain this phenomenon? Light decomposes the silver chlorid and chlorin is liberated as a gas to the extent it is able to overcome atmospheric pressure It is therefore readily understood that decomposition proceeds more quickly and farther in the exhausted vessels than in those under increased pressure The liberation of chlorin will continue until the dissociation pressure of chlorin produced by the action of light above the silver chlorid reaches a certain maximum value We then have a condition of light equilibrium which can be altered by changing the intensity of light If we remove the light energy the pressure will force chlorin back into a combination with silver until the equilibrium in the dark is restored and this takes place most rapidly and most completely under increased pressure

Chemical pressure may be substituted for the mechanical or physical pressure of the example given above Thus these chemical sensitizers for instance absorptives of chlorin such as silver nitrate tannin etc the addition of which to silver chlorid diminishes the dissolution pressure of chlorin and on the other hand oxidizing bodies chlorin and the like will increase this pressure With the Rembrandt printing out paper which contains a chromate the decomposition or darkening process is retarded appreciably This paper is used to obtain good prints from weak negatives

The doctrine of equilibrium conditions during chemical reactions is termed the law of chemical mass effect

Only the reversible cyclic process enables us to accurately measure the work done by any energy such as that of light by determining the pressure which is required to prevent a certain work as in the case of light the darkening of silver chlorid

E Becquerel's photoelectric cell is a much more accurate instrument for measuring photochemical decomposition As electrodes the means for converting luminous energy into electrical energy we use bright sheet silver plates dipped for an instant into a solution giving off chlorin for example a solution of chlorin or one containing mercury chlorid or copper chlorid this causes the plates to become covered with a thin film of silver subchlorid which is dark and sensitive to light The electrodes are placed in a conducting liquid such as a solution of common salt If the two electrodes are connected and a galvanometer included in this connection then by exposing one electrode to light while the other is protected by an interposed dark screen a current will be generated and indicated by the deviation of the galvanometer needle At the exposed electrode chlorin is liberated which travels to the unexposed electrode and there gives off its electrical charge which returns to the first electrode through the connecting wire thus producing the electric current As soon as the pressure of light ceases the chlorin stored at the unexposed electrode, in turns by a diffusion process, and a current of opposite direction flows in the dark. Luther has tried some interesting experiments upon these observations.

We still have to answer the question: What is the nature of the photochemical effect? If we are dealing with those substances which have been formed under considerable evolution of energy (heat), that is, bodies containing stored energy, we have to do work against this energy, the so-called chemical affinity, and this work must be at least equal to the energy developed. This is the case when silver chloride is decomposed. The second type comprises the slow, spontaneous decompositions, such as the bichromated gelatine used in pigment printing; in this case the action of light will accelerate decomposition. Finally, light is capable of starting reactions that in turn will enable some other energy to act and to carry the process to completion. The short preliminary exposure of dry plates followed by the chemical reaction of development may be cited as an instance of this third type.

Now what is the mechanism of the chemical action of light? As we attack this problem we have to admit at the outset that only hypotheses can be offered.

The action of light has been considered a catalytic one, among others. Wilhelm Ostwald has championed this explanation. Catalysis is a theory developed by physical chemistry to account for the peculiar effect of certain bodies, such as finely divided metals, bacteria, etc., which in very small quantities will suffice to bring about reactions between unlimited amounts of other substances. Finely divided platinum, so-called platinum sponge, is capable of causing the otherwise stable mixture of hydrogen and oxygen to combine, just as a spark would do. To consider light as a catalytic agent is, according to K. Schaum, open only to one objection, which is, that a catalyst must always remain unaltered, whereas light is destroyed or rather converted into chemical energy. Other scientists, as Eder and Quincke, suggested a vibration of the particles of the sensitive material in unison with the light. As a matter of fact, light is energy of motion and is well able to disrupt the complex of atoms by continued impact.

Nernst and Arrhenius have attempted explanations based upon the electromagnetic theory of light.

What law governs the absorption of luminous rays? Not the least important factor is the color of the article exposed to light. [illegible] look at the leaf of a [illegible] Why [illegible] spectrum of white light it [illegible] all [illegible] the others which [illegible] green. The general physical explanation of the nature [illegible] finds its complement in the observation that red light is most favorable to the assimilation of carbon, the important chemical process which [illegible] plant to grow. Green light [illegible] incapable [illegible] maintaining plant life as darkness, the total absence of light.

[illegible] in the case just explained colored light leads to the formation of a substance of complementary color (chlorophyll), there are bodies which assume colors corresponding to those of the light falling upon them. Silver chloride may serve as an example, especially if it has been darkened by exposure to light. Experiments may be made readily with silver chloride (printing-out) paper as found in the market; only the exposure should be long enough. Under red glass the silver chloride, which is first of a dark brownish violet, becomes red, and this again blue if exposed under a blue glass, and so forth. Why this apparent contradiction of the facts explained? The answer is given by Professor Wiener: [illegible] substances [illegible] light [illegible]. Such substances are mixtures of the most varied light-sensitive coloring matters. Those that [illegible] the light to which [illegible] exposed, that is, those of the same color [illegible] light, are preserved; all those of a different color are destroyed, [illegible] most of all those of the complementary color, that is, the green coloring matter, in the case of red light. The final result is a color similar to that of the light. The author has succeeded in producing by a purely chemical process various coloring matters of the hypothetical mixture of coloring matters, thus confirming Wiener's theory.

[illegible] photochemical investigations may [illegible] difficult [illegible] results may be completely altered by a number of factors which often appear to be of very inferior importance, and thus a second investigator may frequently find quite different results from the first. This one assertion, however, I may make without being charged with unwarranted boldness:

That photochemistry has a great future, and more particularly the organic reactions offer great interest from the point of view of the physiologist and of the biochemist. If in our remarks we have gone a round-about way and spoken first of inorganic reactions, this has been done because these reactions permit of a more readily understood explanation in view of the well-known photographic processes.—Umschau.

ENGINEERING NOTES.

The Connecticut River bridge at Hartford, over which traffic is now and has been passing since November of last year, is one of the most attractive stone structures in this country, and for this reason the report that cracks have appeared in several parts of it has attracted considerable attention. As a matter of fact, there are no cracks in the bridge proper save such as are apt to occur in the pointing due to temperature, crack that must be expected in nearly a quarter of a mile of continuous masonry. The piers for the bridge are all founded on rock except that of the east abutment, which is heavily piled, and all of these piers may be regarded as solid as they can be made by good engineering. Cracks have developed, however, in the easterly north wing wall, a continuation of the last arch spandrel wall, despite the precaution taken to excessively load the wall before the coping was put on, which has held nearly two years without developing any crack in the wall. There is no theory at which the engineers can arrive to account for the bad crack opening up after the completion of the work. This wall has a separate foundation from that of the abutment on sufficient piles cut off about 8 feet higher than those in the abutment. It is a matter of no serious moment, being simply a wall less than 50 feet long, and at worst can be readily relaid without affecting the bridge, with which it has nothing to do. On the west side high retaining walls flank the abutment on either side of it and at right angles thereto; the north flank is not yet built. The south flank is entirely a separate structure from the bridge, the abutment of which is on rock. The wing wall is on piles and a so-called crack shows up between the wall and the abutment, between which there is no bond, as there never should be between a pier and a wing founded on different bottoms or with different pressures. The partition crack between this wall and the abutment is a mere matter of repointing when convenient.—Engineering Record.

A change in signaling, consisting of a new position of the signal arm for "proceed," has been adopted as standard by the Baltimore and Ohio Railway and will be used in all future installations. The new position instead of being below the horizontal as heretofore is above. No change, however, has been made in the stop indication, the arm being horizontal or at right angles to the mast. The proceed caution indication is given by the arm in the 45-degree position above the horizontal, as compared with a similar position below the horizontal under the old method. The proceed clear indication is given by the arm in the vertical position cut of the line of the mast above the horizontal, whereas under the old method this sign was indicated by a similar position below the horizontal. The operating officials believe that the upper quadrant system provides a more distinct aspect than under the old method. The first test of the new method was begun about three years ago, and though a large number of installations of this type of signal has been made during the past two years, it was not finally adopted as standard until recently.

Mexico, states a contemporary, holds the fifth position in the production of quicksilver in the world, but falls short by a considerable amount of producing enough to supply the home market. Prior to the introduction of the cyanide process for the treatment of the silver ores the importation of quicksilver, known in the Spanish as "asogue," was very heavy, and the necessity of having this metal for the patio process was so great that the Government removed all taxes on quicksilver mining, both federal and state, and provided for the free admission of quicksilver into the country. This same law is enforced today, and is one of the causes stimulating the new developments in the Mexico quicksilver districts. The falling off of production in other parts of the world has turned attention to the Mexican districts, and the prospects of greater activity in quicksilver mining in Mexico are very good.

The compressive strength of concrete when reinforced with separate transverse ties or iron wire arranged in lattice form and when mixed with scraps of iron wire has been investigated by Mr. W. P. Nkrassow of St. Petersburg. He reported to the Copenhagen Congress of the International Association for Testing Materials that when the wires of the lattice are from 1 mm. to [illegible] mm. or less in diameter, the increased resistance to crushing is in every case as great as that of hoops. The same is true with scraps of iron wire when they are 0.5 mm. to 0.25 mm. in diameter.

The first section of the Shanghai-Hangchow-Ningpo Railway, which extends from Shanghai to Fengching, a distance of 38 miles, was opened for traffic on May 30th last. This line was built under Chinese engineers. The preliminary survey of the line was made in the winter of 1907. There are 10 stations and 48 steel bridges on this section. The longest bridges have spans of 440 feet, 400 feet and 200 feet, respectively. The average cost of construction was $35,000 per mile.

TRADE NOTES AND FORMULÆ.

Simple Reliable Black Stain for Brass.—Over 50 parts of carbonate of copper (commercial) pour 350 parts of 10 per cent spirits of sal ammoniac and allow it to stand in a dark colored closed bottle over night. Some carbonate of copper must remain undissolved (we may possibly have to add some to insure this). The whole is diluted with 25 parts of water and is then ready for use. The brass object to be colored black must be scoured absolutely free from grease. It is best to heat it to redness, boil it out and pickle it in the bright dip. Then rinse it well and lay it for 3 to 5 minutes in the black stain. The object will at first turn bluish, then brown, finally deep black as if oxidized. At this stage it should be removed; if allowed to remain longer in the stain the fine color will disappear. Then dry it at once in sawdust and zaponize the object (i. e., cover it with celluloid varnish). After a long time the stain becomes inoperative, but otherwise, if the object has been well scoured, it is reliable.

Angostura Bitters (formula of Siegert).—Cloves 3 parts, angelica root 3 parts, ginger root 3 parts, galangal root 15 parts, gentian root 15 parts, zedvary root 15 parts, small cardamoms 20 parts, cassia 20 parts, bitter orange peel 25 parts, tonka beans 80 parts, red sandal wood 80 parts, brown Peruvian bark 100 parts. Coarsely crush and cut all the ingredients and extract for 15 days with 5,000 parts of 60 per cent alcohol, press, strain and filter. Then add 200 parts of sugar color, 500 parts of Malaga wine, and after settling filter again.—Barsch. Chem. Tech. Lexikon.

Finish for Leather.—*a.* 125 parts brown shellac is dissolved in a boiling solution of 26 parts of borax and 3 parts of caustic potash, the powdered shellac having been previously moistened with a little ammonia. *b.* 36 parts of logwood extract solution of 30 deg. B. (approximately 400 parts of extract per 1,000 parts), 10 parts glycerine, 10 to 20 parts of aniline black and methyl blue dissolved in 300 parts of water. Mix this with the shellac solution, add a mixture of 50 parts of pyrolignate of iron at 20 deg. B. and 90 parts of water, and add a little oil of mirbane and oil of thyme.

Amalgamating salt in fluid form is prepared (*a*) by dissolving 1 part quicksilver in a mixture of 1 part nitric acid and [illegible] parts hydrochloric acid. The solution is effected in a porcelain dish in the sand bath under a well ventilated roof attached like a forge hood to the chimney. (*b*) Dissolve 8 parts commercial corrosive sublimate in 100 parts of water and add 10 parts of hydrochloric acid. Dip the zinc pieces in for an instant, rinse them and brush them off. (May be applied with either a sponge or a brush; never touch with the naked hands.)

Aluminium Bronze Alloy.—*a.* 90 parts copper, 10 parts aluminum, 1/0 per cent of an alloy of 20 parts nickel, 20 parts copper, 30 parts tin and 7 parts aluminum. *b.* Copper plate is electrolytically coated with 1 to 10 per cent of aluminum, then melted together with 1 per cent of the following alloy: Alloy.—20 parts nickel, 2 parts copper, melted under a layer of charcoal; next another 18 parts of copper mixed in. Stir up with an earthenware stirrer 33 parts tin, and finally 7 parts of aluminum to be added. Cast in bars.

Acid Varnish for Heater.—Gall nuts 200 parts, logwood 30 parts, water 200 parts are boiled for two hours, the evaporated water being replaced from time to time; then pass it through a filter. In the filtrate dissolve 40 parts of green vitriol and 200 parts of brown syrup and boil the fluid again until it begins to thicken. Then add a solution of 10 parts of shellac in 30 parts of strong spirits. Must be kept in tightly closed bottles.

Paint That Will Stand Dampness.—*a.* 2 parts coal tar, 2 parts pitch and 1 part of a mixture of burned lime and rosin are to be melted together, and while warm applied several times to the thoroughly dried wood. The last coat to be sanded before it is completely dry. *b.* Melt 12 parts of rosin in an iron kettle, mix and when these ingredients are fluid add as much ocher or umber as may be necessary to make the mixture cover. Then dip the brush in it and coat the object as thinly as possible, repeating the application in a few days.

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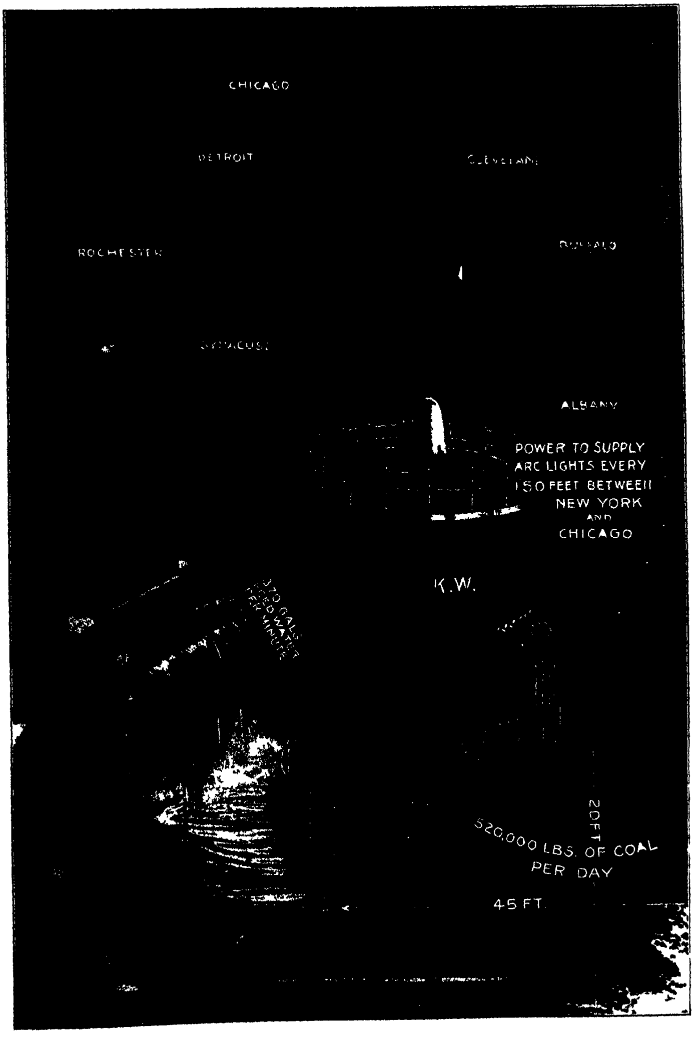

CHICAGO
DETROIT
CLEVELAND
ROCHESTER
BUFFALO
SYRACUSE
ALBANY
POWER TO SUPPLY ARC LIGHTS EVERY 150 FEET BETWEEN NEW YORK AND CHICAGO
K.W.
370 GALS. FEED WATER PER MINUTE
20 FT.
520,000 LBS. OF COAL PER DAY
45 FT.

From Power.

WHAT 14,000 KILOWATTS MEANS

WHAT 14,000 KILOWATTS MEANS.

A GRAPHIC COMPARISON.

The General Electric Company is making some Curtis turbine driven units of 14 000 kilowatts capacity It will be interesting to see what this means in terms which appeal to the comprehension

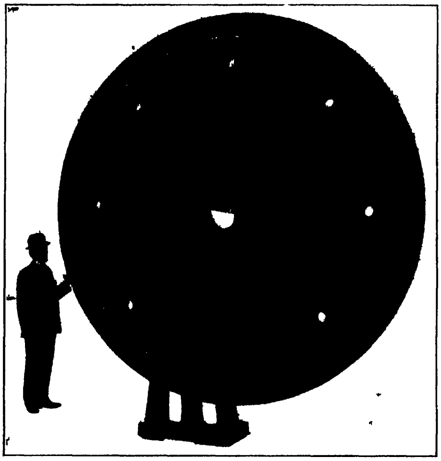
The fifth stage rotating element shown herewith is 152 inches or 12 feet 8 inches in outside diameter and runs at 750 revolutions per minute If it ran along the ground at this rate it would go 5 66 miles in a minute or nearly 8 140 miles a day and would run from New York to San Francisco in about 9½ hours This and the other four wheels which constitute the moving part of the turbine together with the shaft and rotating fields of the generator weigh some 180 000 pounds and yet so freely are they carried upon the cushion of oil that supports the step that this enormous weight can be revolved by one finger

Even at the low rate of 13 pounds of steam per hour per kilowatt this unit would require 182 000 pounds of water evaporated into steam each hour to supply it when running at its rated capacity which would make a 14 3 foot cube The days supply would fill a pond 98 x 150 feet to a depth of over 5 feet and at the usual rate of $1 50 per thousand cubic feet would cost over $105 per day At the 75 pounds of condensing water often furnished per pound of steam condensed it would require 640 cubic feet per minute or as much water as would issue in a jet one foot in diameter with a velocity that would carry it to a height of over 90 feet or as much water as would flow naturally over a weir or dam in a sheet a foot thick and over 18 feet long

It would take to make the steam to run this turbine supposing one pound of coal to evaporate and superheat 84 pounds of water 520 000 pounds or 260 tons of coal per day This would make a cone 45 feet in diameter on the base and 20 feet in height and would take a train of nine 30 ton cars for its transportation Its cost delivered would be for the ordinary case somewhat around $1 000

If all applied to lighting the 14 000 kilowatts which this unit will generate would maintain about 350 000 16 candle power incandescent lamps which if hung in a straight line would supply ample illumination to 600 miles of hallways 10 feet wide or would supply 31 000 arc lamps which if spaced 150 feet apart would illuminate 900 miles of ordinary streets Using the output of this unit for fan motor service 150 000 of these little machines could be kept going The energy delivered at the terminals of the generator during a days run at full load would be sufficient to melt a cone of copper 21 feet in diameter at the base and 100 feet high or 400 miles of copper rod one inch in diameter

The floor space required for the unit proper including the condenser which is inclosed in the base is only about 440 square feet or approximately 32 kilowatts per square foot of floor space It will take two men to operate it and all its auxiliaries not including the boiler room equipment Power



FIFTH STAGE ROTATING ELEMENT OF 14 000 KILOWATT CURTIS TURBINE

THE POTENTIALITIES OF THE AIRSHIP IN WARFARE.

Field Marshal Lord Roberts and Admiral Sir Gerald Noel presiding in succession at a meeting of the Royal United Service Institution left no uncertainty as to their views regarding the potentialities of airships and aeroplanes in future warfare The occasion was a lecture by Major B Baden Powell late of the Scots Guards in which with judicial temperateness he considered the whole question of the effect which airships were likely to have on naval and field operations It is true that the subject was considered more from the military point of view having reference more to the use of airships rather than from the design standpoint but it is as important for the designers of mechanical appliances to study the views of those who are to use the machines as to investigate scientific problems connected with their design One point seemed to be clearly established throughout the discussion and was given expression to by one of the makers of aeroplanes and that was that the ships intended for warfare must differ in important details from those required for recreation or for commerce In the case of the aeroplane it is important that the structure of the planes should be so designed that a hail of bullets would do the minimum of damage to the planes and therefore have the least effect on stability Thus the fracture of a tension or compression member should not involve the failure of the whole plane In the case of dirigible ships again it may be found desirable as it is possible to protect the propelling machinery from such bullets As to the envelope it seems to be accepted as shown by experiments in Germany that perforations by bullets of the gas bag should not greatly affect its carrying power as with certain material the holes of themselves close up while the amount of gas which escapes bears but a small proportion to the total

Major Baden Powell found in the performance of the Zeppelin ship and existing aeroplanes grounds for confidence that they could realize the requirements of the military officer in speed elevation and radius of action He put the available speed at from 2 to 35 miles per hour the height at 5 600 feet and the radius at 360 miles in the case of the airship while as far as aeroplanes were concerned the greatest speed was assumed at from 40 to 50 miles the maximum altitude so far attained 2 000 feet and the greatest distance traveled 144 miles in 4 hours 17 minutes As one of the speakers put it what one has to consider is not so much what has already been achieved but rather the possibilities of further advancement The principal obstacle to the dirigible is the great size of the shed required for storage but this may be overcome by utilizing such depressions as quarries throughout the country The variation in temperature too involves a serious change to the lifting power Thus a difference of 10 deg F which is not infrequent within twenty four hours at almost any season involves a change in the capacity for lifting of one twelfth of the total while damp and snow also create difficulties As to the aeroplane the gallant Major did not seem to place the same weight as others upon the inability of the aeroplane to hover over its prey considering that by stopping the propeller the machine could be allowed to fall vertically which would be equivalent to arresting progression while the same result could be achieved in the event of a strong wind by turning the machine to face the wind The dirigible he agreed in this respect has material advantages Although the reduced density of the air at an elevation of 5 000 feet would require an addition of 20 000 cubic feet of gas to the volume required to lift the ship a dirigible balloon could rise more quickly by discharging ballast and could carry a greater weight of passengers and of ammunition although half a dozen aeroplanes might do the same work and cost less If the engine stopped it would not be compulsory to descend and for the same reason it could remain longer in the air without running the engines On the other hand the aeroplane was smaller easier to manage on the ground cheaper more quickly made more easily repaired in the field was comparatively invulnerable was not affected by atmospheric change traveled faster and presented a smaller target

There seemed to be a consensus of opinion at the meeting against the overestimation of difficulties of aerial navigation even in darkness and Col. Capper referred to the value of practice with balloons whereby trained aerial navigators could pick their way with surprising facility in the dark and even in slight fogs In this respect the dirigible has enormous advantages especially when working on compass bearings Major Baden Powell gave some results as to the average velocity of the wind at various altitudes for this country and for Germany At corresponding altitudes in Germany the velocity was considerably less Thus at ground level the average for England was 18 miles per hour, at 1 500 feet 28 miles at 3 000 feet 30 miles and at 5 000 feet 36 miles per hour At Lindenburg near Berlin on the other hand the rate at ground level was 11 miles per hour, at 1,500 feet, 20 miles at 3 000 feet 21 miles and at 4 500 feet, 21 miles The Zeppelin ship therefore seems to have the advantage in Germany Col Capper did not consider that such variations in the wind velocity at different altitudes materially affected the navigation of the air as the wind was fairly constant at a given altitude and the navigator naturally kept to this altitude so that the navigation at night did not seem to raise any serious obstacle even although the lights of towns in time of warfare were extinguished

One utility of the airship or aeroplane is undoubtedly associated with reconnaissance work Irrespective of the speed of travel it is possible at great altitudes to discover opposing forces in a manner quite impracticable where the curtain has to be penetrated on the ground level For practical reconnaissance work 10 or 15 miles was considered a sufficient radius, and for strategical work, 40 or 50 miles, according to Major Baden Powell But Col Capper differed from this view believing that, as the radius of action was largely a question of fuel, it would be well to provide for very much wider range of observation, because it became of the utmost importance to a general to know what was proceeding even in distant towns in the direction of mobilization and movement of troops

Aeroplanes would certainly be more useful for a raid and indeed for movement of troops than the dirigible ship, but it would be necessary, of course, to have a very large number of such aeroplanes carrying three or four men in addition to the driver They would also be of considerable benefit for the carrying of despatches and communications, for duty with scouts, or for providing a coign of vantage for a commander-in-chief during action There seemed to be some difference of opinion as to the extent of destruction which might be done by the discharge of explosives; but on this point the potentialities are sufficiently serious to justify very careful consideration. Much of what has been written, of course, is applicable to naval warfare as far as reconnaissance work is concerned, although it is a point of doubt as to whether a destroyer with a captive balloon could not do better work than an aerial ship

We will not follow Major Baden Powell into the more speculative field as to the advantage of duels in the air between two dirigibles a dirigible and an aeroplane, and two aeroplanes An aeroplane attacking a dirigible, it was thought would play the part of the hawk to the heron and as to an encounter between two flying machines of corresponding type the advantage, of course would largely rest with the one having the greatest speed and power of attack This raises the question of the possibility of arming airships and of the most suitable weapon to use Major Baden-Powell contemplates eventually the use of some form of pompon and a missile of the nature of a dart with knife like barbs in order to cut the envelope of the airship while the application of various chemicals was suggested in order to set light to the hydrogen in the gas cylinder

After all however the more serious problem from the national point of view is the means of defense against possible attack by airships and it seems in view of the undoubted activity of Germany in providing a fleet of airships as if some systematic defensive measure were necessary We must meet airship with airship somewhat on the same principle that a battleship is built to meet the enemy's ship and similarly it is essential that the enemy's country must be our line of frontier in the air as on the sea It is therefore incumbent upon the Admiralty as well as the War Office to offer every encouragement to the designers of aeroplanes in order to arrive at the best results to meet all conditions which may obtain At the same time it is equally important that land defenses should be provided and these it was generally agreed should take the form of light rapid firing guns which could be readily fitted to the chassis of any motor car These guns would require of course to have a very high angle of fire in order to combat an airship traveling at an altitude of 4 000 feet or 000 feet Aerial torpedoes in the form of improved rockets were suggested as well as some form of aerial mines suspended at short distances by small captive balloons in order to protect zones over our cordite supply factories and stores over the great arsenals and ship and ordnance repairing establishments and over points which would most likely be attacked because their destruction would most fully influence the maintenance of our forces —Engineering

MARINE PROPULSION BY ELECTRIC MOTORS.

THE PLAN OF MR. H. A. MAVOR.

A COMPARATIVE study of the methods of applying power on land to the propulsion of vehicles and other purposes and of the methods adopted at sea shows that while the problems have much in common there are differences in methods and in experimental results which have mutually interacted from time to time between land and sea practice tending toward assimilation with a gradual improvement in the economic results in both cases

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each The steam turbine and the non reversible internal-combustion engine introduce a new set of conditions On land the turbine holds the field for the largest powers and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes its evolution has been directly associated with electrical transmission These turbines are many of them of the same order of magnitude as the turbines used on shipboard and therefore a comparison of economy in the two conditions is inevitable

Before the introduction of electric transmission the marine engineer had the more complete scientific data and consequently the marine engine held the blue ribbon of economy which now belongs to the turbo electric generator Among the reasons for the higher efficiency of the land turbines are That the engineer on land is freer than is the marine engineer to adopt a suitable speed of revolution, that the land turbine runs at approximately constant speed for all loads and can therefore be run on the governor rendering easier the application of superheat and augmented vacuum that on land it is possible to subdivide the power units to meet the conditions of varying load and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system that at sea change of power is directly associated with change of speed, and the whole of the power units must always be in motion while the ship is in motion The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits Also the high economy on land of power production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load giving a complete knowledge of the effect of all changes in the apparatus or in the methods of working it

In a paper read before the Institution of Civil Engineers H A Mavor makes the proposition to provide an electric equipment intermediate between the prime mover and the propeller extending the limits of practical economy in each by modifying the restrictions which the prime mover and propeller impose upon one another and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated At full power all the elements of the generating plant are in full operation and the whole power resources can be concentrated on driving the ship When full power is not required the generating plant may be shut down in sections

To accomplish these ends special motors have been designed which give the necessary changes of speed and direction and permit of the advantageous combination or elimination of the power generators These motors involve no new electrical principle but simply mechanical adaptation of well known electrical designs Alternating current alone is available for the purpose in question and normal motors have therefore a fixed speed of rotation which is a simple multiple of the generator speed

Two methods of speed change are proposed by Mr Mavor each is associated with a new form of motor

The principle of operation of the Spinner motor is that an ordinary normal motor driving the propeller at a fixed speed with the shaft and propeller directly connected is so arranged as to be rotatable as a whole about the propeller shaft axis This rotation is accomplished by a second motor concentrically arranged outside the first so that the main motor system may be rotated in each direction—again at a fixed speed which is a simple multiple of the generator speed and the speed of rotation of the propeller shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor

As both motors are reversible it will be seen that in each direction there are three speeds

1 The speed of the main motor system the middle speed
2 The speed of the main motor system minus the speed of the auxiliary motor system the low speed
3 The speed of the main motor system plus the speed of the auxiliary motor system the full speed

The combination may be designed for any three speed ratios such as 1 2 3 9 4 etc Any intermediate speeds required are attainable by adjustment of the turbine or engine governor which can be operated economically through a range down to about 75 per cent of full speed The same method is applicable to non reversible internal combustion engines

The multiple motor is an ordinary squirrel-cage induction motor in all respects except that its stator is wound with two or more independent electric circuits each associated with a separate source of supply of energy

For example the motor may be fed from two sources of supply at 2 and 50 periods respectively the motor windings being for 48 and 92 poles At full power and speed both windings are in operation under their most advantageous conditions each of these windings results in a synchronous speed of 65 revolutions per minute When the 2 period current is supplied to the 92-pole winding the speed is 33 revolutions per minute

Either of these motors permits of one or more generators being used together in the same mechanical system without electrical connections or synchronizing devices

Mr Mavor then discusses the application of electric propulsion to certain definite types of ship and also gives diagrams illustrating the saving in space obtained The examples worked out are as follows

(i) In a cargo vessel of 810 shaft horse power the normal reciprocating engine equipment with a single screw would weigh 570 tons for engines boiler and fuel The electrical equipment consisting of three oil engines three motors and three propellers would weigh only 270 tons including fuel Further with coal at $4 0 per ton and oil at $ 00 per ton the saving in fuel cost on a total of $8 would be $ 6 50 per day at full power

(ii) In a similar cargo vessel gas engines might be used Taking an equipment of 770 shaft horse power and using three gas engines and one multiple motor the respective weights of the normal and proposed equipments would be 446 tons and 229 tons The consumption of fuel shows an equally favorable comparison

(iii) A third cargo vessel but of 1 030 shaft horse power is worked out for the purpose of illustrating the application of steam turbines to the multiple motor One plant drives the ship under normal conditions extra power is supplied by a small turbo generator and is used to keep up the ship's speed in heavy or contrary weather

(iv) On a passenger vessel of say 10 00 shaft horse power the electrical equipment permits of a subdivision of the plant so that at ship speeds lower than the maximum only part may be run and that at full power This advantage is gained without loss in full power economy and without additional complication

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Luminous Paint, Showing White and Colored Lights in the Dark—*a* White Mix Japan varnish 40 parts (Zanzibar or Kauri copal melted over a charcoal fire 15 parts of the melted mass is dissolved in 60 parts of French oil of turpentine then filtered and mixed with 25 parts of previously heated but somewhat cooled linseed oil) with 6 parts of prepared sulphate of baryta, 6 parts prepared carbonate of lime 12 parts of prepared white sulphide of zinc 36 parts of luminous sulphide of calcium, and mixed in a suitable vessel or a receptable and then ground very fine in a paint mill *b* Red 50 parts Japan varnish 8 parts prepared sulphate of baryta, 2 parts prepared madder lake 6 parts prepared red disulphide of arsenic 34 parts luminous sulphide of calcium, *c* Orange 46 parts Japan varnish, 17 5 parts prepared sulphate of baryta 1 part prepared Indian yellow 1 5 part prepared madder lake 48 parts of strongly luminous sulphide of calcium *d* Yellow 48 parts Japan varnish 10 parts prepared sulphate of baryta 8 parts chromate of baryta 34 parts of strongly luminous sulphide of calcium *e* Green 48 parts Japan varnish 10 parts prepared sulphate of baryta 8 parts oxide of chromium and 34 parts luminous sulphide of calcium *f* Blue 42 parts of Japan varnish 10 2 parts of prepared sulphate of baryta 6 4 parts ultramarine 5 4 parts cobalt blue 36 parts luminous sulphide of calcium *g* Violet 42 parts of Japan varnish 10 2 parts prepared sulphate of baryta, 2 8 parts ultramarine violet 9 parts arsenate of cobalt, 36 parts luminous calcium sulphide *h* Gray 45 parts Japan varnish 6 parts prepared sulphate of baryta 9 parts prepared carbonate of lime part ultramarine blue 6 parts gray sulphide of zinc and 36 parts luminous sulphide of calcium *i* Yellowish brown 48 parts of Japan varnish 10 parts prepared sulphate of baryta 8 parts auripigment 34 parts luminous sulphide of calcium For art purposes use in place of Japan varnish equal quantities of pure Fast Indian poppy oil For oil color prints (chromos) in place of Japan varnish use equal parts of pure linseed oil (cold pressed and thickened by boiling) *for* glassware and porcelain in place of Japan varnish use 10 per cent more Japanese wax with one fourth the quantity of olive oil

REGISTERING LETTERS BY SLOT-MACHINE.

A NEW FRENCH AUTOMATIC CONTRIVANCE.

BY LUCIEN FOURNIER.

AUTOMATIC machines for vending postage stamps and postal cards are already in use in Paris, and a very ingenious machine for registering letters, the invention of Antal Loder, has recently been installed at one of the postal stations.

A 25-centime piece is inserted in the slot at the right side of the machine (Fig. 1). The letter, bearing stamps sufficient for ordinary postage, is placed in the opening at the top with the address side in contact with a plate which overhangs the opening, the handle is turned, and in a few seconds the letter is registered and a receipt for it falls from the tube marked "Recus" near the bottom of the box in front.

The mechanism is too complicated to be described in detail, but a general idea of it can be given. The very original devices by which imitation coins are rejected and the registration proper is effected are especially worthy of mention.

The new French 25-centime piece is made of nickel and the genuineness of the coin slipped into the machine is tested by taking advantage of the fact that nickel is slightly, and only slightly, magnetic. The coin, after it has been inserted in the vertical slot O (Fig. 2), which is just high enough to admit it, rolls down the inclined passage, the sides of which are cut away to a height E sufficient to cause any coin appreciably smaller than the genuine 25-centime piece to fall out laterally. After passing these tests for size the piece comes within the influence of the magnet A. If it is of nickel it is deviated by the attraction of the magnet just enough to fall into the tube F and set the mechanism into action. If it is a piece of iron or steel it is attracted more strongly and stopped, so that it falls in front of the tube and is expelled from the apparatus. Finally, a piece of lead or other non-magnetic metal is not attracted at all, but continues its course unchecked to a passage which delivers it outside the machine. This very simple device operates with perfect certainty.

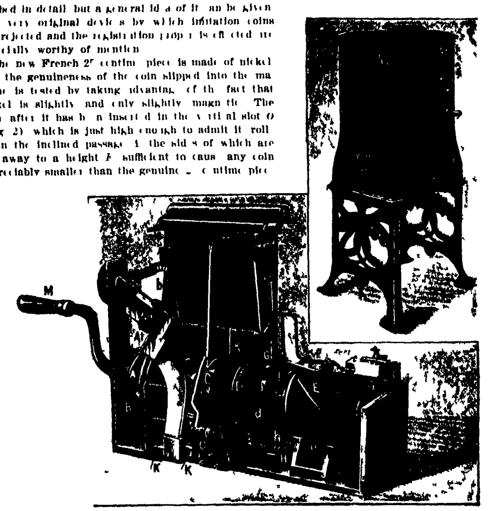


FIG. 1.—AN AUTOMATIC MACHINE FOR REGISTERING LETTERS.

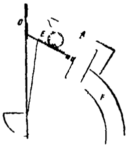


FIG. 2.—DIAGRAM OF COIN-TESTING DEVICE.

The mechanism comprises three groups of organs, one operated by the coin, another by the letter and a third by cams attached to the shaft of the crank. But the crank cannot be turned until it has been released by lifting the lid of the letter slot, and this lid cannot be lifted until the coin has been inserted in the coin slot. As the handle is turned the letter is raised to a vertical position and pushed into a corner where the number and date are stamped upon it. Meanwhile a blank receipt ticket has been presented to another stamping machine, so that the date and serial number are stamped simultaneously upon the letter and the receipt. The ticket is delivered to the sender through the lower tube already mentioned and the letter falls into a locked box from which it can be removed only by the official receiver of registered letters.

The system of stamping includes an ingenious device which makes it impossible to obtain a registry receipt by inserting a coin without inserting a letter. This result is accomplished by means of a rod which, pressed by the letter on its arrival at the proper position, releases a spring which sets in motion the stamping mechanism. If no letter is present the mechanism does not work.

An interesting recent modification of the method of release of the crank shaft by the insertion of the coin is illustrated by Fig. 4. The coin falls into a receptacle R suspended freely from an axis A. The raising of the lid of the letter slot causes a rod L to enter a channel which extends horizontally through this receptacle. The rod, pressing against the coin, turns the receptacle on its axis and by this means releases the crank shaft, but if no coin is present the rod simply passes through the receptacle without moving it. Hence, even if the lid could be raised before insertion of a coin, the crank shaft would remain locked and the machine would not work.

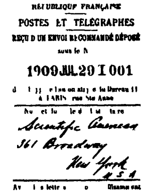
This ingenious postal automaton effects the registration of letters very rapidly and with every guarantee of security. The ticket which it delivers (Fig. 3) serves as a receipt. The name of the addressee is subsequently written on the ticket by the sender. The possibility of error or fraud is completely eliminated.—La Nature.

FRENCH EXPERIMENTS ON THE EFFECT OF SHELLS IN NAVAL WARFARE.

THE French government has recently completed an interesting series of experiments on the effect of shells in naval warfare. An obsolete warship, the Iéna, was selected as the object of attack, and was anchored in the harbor of Hyères, near Toulon. The attacking vessel approached within 500 or 600 meters (1 640 or 1 968 feet) and took aim with the greatest possible precision in order that its projectile should strike a particular part of the Iéna. The firing charge was not the regulation charge for the caliber and projectile employed, but was calculated to make the striking velocity of the shell, fired at this short range, equal to the velocity which it would have had on striking if it had been fired from a distance of 6 000 meters (19 685 feet) with the regulation charge. As a result of experiments which have been conducted during several years it was possible to calculate the reduced charge with almost perfect accuracy.

The attack was opened with guns of calibers of 140 millimeters (5.5 inches) and 194 millimeters (7.64 inches). These comparatively small shells were aimed at the thin armor of the casemates and at the unarmored parts of the vessel. The damage inflicted was considerable, and in some respects exceeded all expectations. For example, bursting shells which contained explosive charges equal to only 2 per cent of their weight sufficed to start a conflagration in a casemate and to explode cartridges which had been placed therein.

Since the Russo-Japanese war great importance has been attributed to the asphyxiating effects of explosive shells. The experiments with the Iéna were arranged to test this question. Dogs, rabbits and pigeons were placed in the casemates, gun turrets and batteries. The search for exact truth was even carried so far as to attach over the hearts of some of these animals microphones which were connected with receivers on the attacking vessel for the purpose of observing the physiological effects of the shots, but this refinement was soon abandoned owing to the insignificance of the results obtained. To the great surprise of the officers the dogs, rabbits and pigeons were found alive and uninjured after most of the experiments.



RÉPUBLIQUE FRANÇAISE

POSTES ET TÉLÉGRAPHES

REÇU D'UN ENVOI RECOMMANDÉ DÉPOSÉ

sous le N°

1909 JUL 29 1 001

à PARIS rue Ste Anne

Scientific American
361 Broadway
New York
U S A

FIG. 3.—A RECEIPT DELIVERED BY THE MACHINE.

The attack was continued by the Suffren with guns of 305 millimeters (12 inches) caliber and with the new and heavy shells weighing 440 kilograms (970 pounds) and containing 17 kilograms (37½ pounds) of melinite, which are henceforth to be used exclusively by French warships of the Danton type. The results obtained were very gratifying. The new shell proved to be adapted perfectly to the ballistic conditions for which it was designed, and its perforating and explosive effects were startling.

The sensitiveness of the exploding mechanism of shells was also studied in these experiments. Exploders of various types were used with shells of each of the three calibers employed. All of these exploders are based on the principle of centrifugal force and are placed at the rear end of the shell. They automatically set themselves in readiness for action when the shell attains its maximum velocity of rotation, at the moment of leaving the gun, and they cause the explosion when this velocity is suddenly diminished by the entrance of the shell into the armor of the vessel attacked. Hence their regulation is a very delicate matter, for they must not act on mere contact and yet are required to act when the shell perforates a thin armor plate. Various exploders of this type, of French and foreign make, were tested, and valuable data concerning their relative efficiency were obtained.

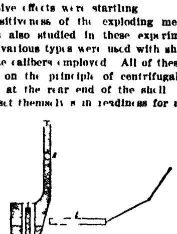


FIG. 4.—NEW DEVICE FOR RELEASING THE CRANKSHAFT.

In spite of this series of bombardments, the old Iéna is still afloat, and will be used for another course of experiments in which the attacking vessel will be stationed at a distance of 6 000 meters (19,685 feet), and will use the regulation service charge.—Cosmos.

BOTTLED LIQUID GAS FOR BALLOONS.

LIQUID HYDROGEN AND ITS USE IN AERONAUTICS

THE greatest difficulty in the liquefaction of hydrogen consists in the construction of a suitable cooling device In liquifying air the refrigeration obtained by the expansion of the compressed gas suffices but in the case of hydrogen more energetic means are required for the following reasons Hydrogen has a very high molecular velocity and is one of the few gases which becomes warmer on escaping into a vacuum This heating effect occurs at all temperatures above —166 deg F Hence the gas must first be cooled to this temperature before it can be liquified by expansion This preliminary cooling is usually effected by the evaporation of liquid air in a vacuum

FIG 1—FILLING AND WEIGHING FLASKS OF LIQUID HYDROGEN

According to Umschau for the production of one liter (2.2 pints) of hydrogen Kamerlingh Onnes the leading authority in the liquefaction of gases found it necessary to employ 3 horse power and 2 liters (4.4 pints) of liquid air He then succeeded by means of an ingenious device in purifying the liquid to 99.9 per cent

Liquid hydrogen is easily transported as its weight is only 1/15 that of water and its volume only 1/800 that of hydrogen gas The handling and transportation are both convenient and safe The process of filling and weighing the flasks of liquid hydrogen is shown in Fig 1 The evaporation at the place of employment offers no difficulty For small quantities the apparatus shown in Figs 2 and 3 which was originally devised for the respiration of oxygen at high altitudes may be employed When the cock *h* is closed a certain excess of pressure is produced in the vessel *V* which expels the liquid hydrogen through the sieve *R* into the vertical tube *ss* which ends above in the cylinder *F* made of wire netting Through this netting the liquid escapes into the metallic globe *K* where its evaporation produces a strong current of gas

FIG 2—SMALL APPARATUS FOR EVAPORATING LIQUID HYDROGEN

For the transportation and evaporation of larger quantities of liquid hydrogen for filling balloons the double-walled gas bag, shown in Figs 4 and 5 is employed The space between the two bags is filled with eiderdown.

As liquified hydrogen occupies little room and when evaporated possesses great lifting power it appears especially suitable for employment as ballast instead of sand. In dropping sand ballast the buoyancy of the balloon is increased only by the weight of the ballast dropped, but if hydrogen ballast is used the buoyancy may be further increased by the lifting power of the gaseous hydrogen which is turned into the balloon With dirigibles of the flexible type the use of liquid hydrogen is still more promising The dirigibility of these balloons is dependent upon the maintenance of their form by the distension of the gas bag, but as no bag is completely gas tight losses are unavoidable Hence all dirigible balloons of the flexible and semi rigid types are provided with interior gas bags called ballonets which are filled with air and are inflated in proportion to the loss of hydrogen Although in the Parseval airship these ballonets serve well for vertical steering they do not perfectly accomplish their second purpose of keeping the balloon rigid and the progressive substitution of air for hydrogen causes a decrease in buoyancy which must be compensated by dropping ballast By the use of liquid hydrogen ballast it is possible to keep the buoyancy constant Fig 6 illustrates an experimental balloon below which is a flask *F* filled with liquid hydrogen Flasks of this kind which almost entirely prevent the loss of heat by conduction or radiation were first constructed by Weinhold and are known as Thermos bottles The liquid hydrogen is evaporated by passing a current of electricity through a coil of wire in the interior of the flask

If the buoyancy of the balloon has diminished it is only necessary to evaporate a little of the hydrogen in this way The operation is performed by connecting the copper wire *d* through a regulating resistance with four or five storage batteries of an aggregate tension of eight or ten volts and then gradually cutting out the extra resistance until the coil in the flask becomes hot enough to evaporate the hydrogen with the required rapidity With all resistance out the flask of hydrogen is evaporated in less than an hour The Weinhold flask contains 2 liters (4.4 pints) of liquid hydrogen and yields [illegible] cubic feet of hydrogen gas possessing a lifting force of nearly 4 pounds Furthermore the evaporation is equivalent to a loss of 4 ounces of ballast It is true that the buoyancy is diminished by the expulsion of a portion of the contents of the balloon but this loss is diminished in proportion to the contamination of those contents with air and to the lack of fullness of the balloon In unfavorable conditions i e with a freshly filled balloon the net increase of buoyancy produced by one flask of liquid hydrogen is a little more than two pounds In favorable conditions i e, when the balloon has lost much gas the increase of buoyancy may amount to four pounds

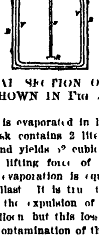


FIG —VERTICAL SECTION OF APPARATUS SHOWN IN FIG 2

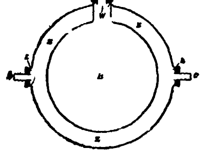


FIG 4—SECTION OF DOUBLE WALLED GAS BAG FOR TRANSPORTING AND EVAPORATING LIQUID HYDROGEN

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The commutator of a dynamo or motor gives better results and wears less rapidly if it can be made to glaze over As it is necessary in electro-plating dynamos to use copper brushes it is more difficult to glaze the commutator than when carbon brushes are employed. Owing to the low conductivity of carbon, they would have to be made much larger than those of copper to carry the same current The following composition has according to the Brass World been found excellent for glazing the commutators of electroplating dynamos Dissolve 4 oz of caustic potash in 1 pint of water and then boil and add 1 oz of flowers of sulphur Boil until sulphur is wholly or partially dissolved making a yellow colored solution Then add lard oil and boil until a soap is made Cool and add a mixture of equal parts of flowers of sulphur and graphite—very fine or that known as electrotypers graphite—until a thick paste is produced This is applied to the commutator but very little is needed to produce the desired result

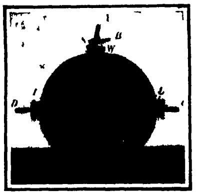


FIG 5—DOUBLE WALLED GAS BAG FOR TRANSPORTING AND EVAPORATING LIQUID HYDROGEN

INSTANTANEOUS X-RAY PHOTOGRAPHS

A METHOD of making X ray photographs of the interior of the human body in a small fraction of a second has recently been invented This invention is of great medical importance When we remember that the blood vessels and many other organs are set into vibration by the pulsations of the heart it becomes evident that it has hitherto been impossible to obtain sharp X ray photographs of the chest or even of the abdomen In the heart itself the amplitude of this oscillation is about two fifths of an inch in other organs the amplitude decreases in proportion to the distance from the heart Dessauer has recently succeeded in obtaining good X ray photographs with an exposure of one one hundredth of a second This was accomplished by energizing the Roentgen ray tube with an impulsive current of this duration The device by which the primary current of the induction coil is interrupted consists of a wire of carefully calculated dimensions covered with a thick coating of some hygroscopic material such as plaster or clay and inserted in the primary circuit This wire is heated by the current to its fusing point In this way water vapor is produced the pressure of which very soon causes an explosion and breaks the wire The self induction spark is extinguished by the fine particles of dust arising from the explosion By this method it is possible to photograph the separate phases of the movements of the heart Prometheus

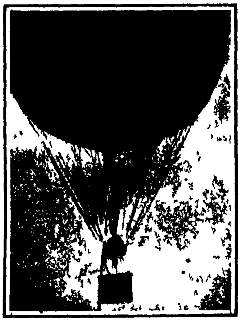


FIG 6—BALLOON WITH ATTACHED FLASK OF LIQUID HYDROGEN

MINERAL OILS MIXED WITH CONCRETE.

SOME INTERESTING POSSIBILITIES.

BY ALBERT MOYER, ASSOC. AM. SOC. C.E.

The mixing of oil (mineral) with concrete is very simple. The oil, alkalis and water will form an emulsion, becoming thoroughly incorporated in the concrete. If the concrete is to be mixed by hand, proceed as usual, and after the water has been added, the resulting mass turned and raked, add non-volatile mineral oil in proportion of 10 to 15 per cent of oil to the weight of the cement. Turn the concrete with shovels two or three times, raking while turning; the oil will quickly emulsify and become thoroughly mixed in the concrete.

If machine mixing is employed, use a batch mixer, turning a sufficient number of times to mix the cement thoroughly, sand, crushed stone or gravel and water. Then add 10 to 15 per cent of non-volatile mineral oil. Turn again the same number of times as it requires to mix the concrete. The oil will quickly emulsify and become thoroughly incorporated in the concrete.

Oils added to cement in proportions of from [illegible] to [illegible] per cent will slightly delay the initial and final set. Increasing proportions of oil will further retard both the initial and final set and hardening, but up to [illegible] per cent, from experiments so far made, it would seem that the retarding of hardening will not be sufficient to cause the work to be uneconomical.

The tensile strength will necessarily be reduced, and with the increasing percentages of oil toughness will be slightly diminished, but not in proportion to the increase in the percentage of oil used.

An extremely interesting paper was read at the meeting of the Association of American Portland Cement Manufacturers at the Hotel Astor, New York, December 1[illegible]th, 190[illegible], by Logan Waller Page, Director Office of Public Roads, Agricultural Department, Washington, D. C., on the subject of the "Possibilities of Portland Cement as a Road Material," in which he described some investigations being carried on by Dr. Allerton S. Cushman in the laboratory of the Office of Public Roads to ascertain the practicability of mixing semi-asphaltic base oils with Portland cement concrete, with the object of obtaining the desirable properties of both Portland Cement and Asphaltum. So far only pats and briquettes have been made; the results obtained show ample strength for ordinary work; six-inch cubes will be tested later.

It is believed that compression tests will show greater strength than the usual relation of compression to tension. This is a matter for further investigation, and it is to be hoped that chemists and cement testers will actively take up this work and carry on investigations covering long-time periods.

Tensile strain tests should be discarded. Such tests have now been discarded by the German Portland Cement Manufacturers and compression tests substituted. With the increased scientific knowledge and the consequent better material produced by Portland Cement manufacturers, tensile strain tests have become obsolete, and owing to the brittleness and extreme sensitiveness of neat Portland cement, the unscientific methods employed in tensile strain tests, the personal equation involved, tensile strain tests do not indicate the possible load which Portland cement concrete may carry.

I would therefore earnestly advocate compression tests on cylinders of a size which will cause the area to equal 6 inch cubes. In order that such tests may be standardized and relative, standard sand should be used, and if possible a standardization of gravel or crushed stone. If crushed stone, trap rock should be used, all passing through a ¾ inch mesh and all collected on a ¼ inch mesh. Mix up cylinders which will theoretically figure maximum density, add varying proportions of oil from [illegible] to 20 per cent. Also make up another set of cylinders adding varying proportions of hydrated lime from 10 to 30 per cent, increasing the percentage of oil with the increase of hydrated lime. The addition of hydrated lime theoretically should permit the addition of a larger percentage of oil, as we thus have a greater emulsifying material. Varying percentages of Portland cement may be used, always keeping the relation between the sand and stone the same, maximum density having been figured. The amount of Portland cement should be increased above that which is required to fill the voids in the sand.

Two months ago the writer made some briquettes and pats with the object in view of ascertaining if the mixture of oil with wet neat cement and mortar would have the tendency of keeping all but the excess water from leaving the wet, neat cement or mortar.

Briquettes were made, neat cement mixed with water, the water slightly in excess of that usually required, after which 10 per cent of oil petrol was added. (Oil petrol is a white non-volatile petroleum product of about the consistency of melted vaseline.) Pats were made of 1 part cement, 3 parts sand mixed with water a little in excess of what would ordinarily be used, after which 10 per cent of the same oil was added. These pats are about [illegible] inches in diameter and ¼ inch thick.

As soon as made they were left in dry air, and the initial and final set was found to be normal. They were never immersed in water but remained in dry air for several weeks. No cracks occurred, and they became so hard and strong that these pats, only one quarter inch thick, were very difficult to break by the use of the fingers and thumbs. After remaining in dry air for three weeks they were put out in freezing temperature for three days, and again placed in dry air over the radiator. No cracks or checks have occurred.

After remaining in dry air for a month a test for absorption was made. A broken pat was weighed dry and found to weigh [illegible] ounce. It was then immersed in water for several hours. Upon removal from the water the surface water was quickly removed with blotting paper, the pat immediately weighed and found to weigh [illegible] ounce. Only [illegible] ounce of water was absorbed.

The fact that the pats were never immersed in water and showed no evidence of checking or cracking and became hard would indicate that the emulsified oil had held the water in the mortar, and that such mortar was therefore both non-evaporative and non-absorbent, which would tend to show that concrete in which mineral oil has been mixed would not be likely to contract, and therefore contraction cracks avoided.

Under the theory of Prof. Bauschinger, which has been demonstrated by Prof. Swain in the laboratory of the Institute of Technology, Boston, neat cement when set and hardened in air contracts, and this contraction increases with age up to a certain period, possibly six months or a year. 1 part Portland cement, 3 parts sand hardened in air shows contraction, but less in proportion than neat cement. The results also prove that neat cement when hardened under water shows a slight expansion, while mortar composed of 1 part Portland cement, 3 parts sand hardened under water shows expansion, but less in proportion than the neat cement. Reducing these conclusions to figures and taking the average results obtained by various authorities, figuring the expansion and contraction by percentage, the following are the results:

Neat Portland cement hardened in air at the end of 16 weeks shows 0.15 per cent contraction.

1 to 3 mortar hardened in air at the end of 16 weeks shows 0.05 per cent contraction.

Neat Portland cement hardened under water at the end of 16 weeks shows 0.0[illegible] per cent expansion.

1 to 3 mortar hardened under water at the end of 16 weeks shows a 0.01 per cent expansion.

(See "Hair Cracks," Albert Moyer, Engineering Record, December 16th, 1905.)

Mixing oil with concrete from the meager tests so far made would seem to indicate that the oil held the water in the mortar, keeping the cement particles wet, and thus furnishing the same conditions as if set under water, hence very materially assisting, if not altogether obviating contraction cracks and hair cracks or crazing. Furthermore, the resulting mortar appears to be far less brittle, and therefore such treatment should admirably serve the purposes required of concrete retaining walls, foundations, inclosing cellars, tanks, cisterns, etc.

Exhaustive tests have been made by a number of authorities on the action of oils on concrete. The effect of oil on concrete and the effect of oil emulsified in concrete are two separate and distinct subjects.

We are informed by reliable authorities that concrete immersed in animal or vegetable oils will in time disintegrate, and that concrete immersed in mineral oils is unaffected. In the first instance there was no chance for the oil to emulsify; in the latter the oil is separated into minute globules. A large field of usefulness is ready for oil mixed and emulsified in concrete. The emulsion takes place after the oil is mixed with the wet concrete, and not before as has been done in a patented article.

A mere casual glance at the uses of Portland cement concrete would indicate that oils mixed with the concrete would prove very desirable for dustless waterproof floors for office buildings, for slaughter-house non-absorbent floors, impervious concrete drain tile and sewers. If the experiments to be carried on in the future prove that mineral oils in the course of time are not disadvantageous, the drain tile problem has been solved, for there can be no action of the alkalis or other injurious elements to non-absorbent dense and impervious concrete.

Such concrete will be particularly desirable for silos. Some of the acids formed by the silage in the bottom of the silo would probably not attack a dense, non-absorbent impervious concrete.

Contraction cracks will be eliminated in cisterns, drinking troughs, live stock feeding floors and platforms. Some objection may be raised to the use of oil mixed concrete from the standpoint of its liability to flavor the water or the food. If we stop to consider that the oil is divided into minute globules thoroughly emulsified, we will see that while there may be some odor there is not likely to be any taste after the drinking trough, feeding floor or cistern has been in use for a few days.

Such oil mixed concrete will be effective for liquid manure cisterns for the reason above described. It will also be particularly adapted to terrazzo floors, the great objection at present being due to contraction cracks. A white oil may be mixed with Portland cement, white sand and water and used for the purpose of setting brick and stone; it being non-evaporative and non-absorbent, no efflorescence or stains can occur. In fact such concrete can be used in any work not requiring extraordinary compression strength and in which it does not come in contact with heat.

One of the particular advantages will be for stucco work and exterior plasters.

It would seem that this idea of mixing oil with wet mortar is new, but like many discoveries it proves to be only a rediscovery. In the first century A. D. Marcus Vitruvius Pollio, the famous Roman architect, gives the following detailed specification for stucco:

A mixture of well hydrated lime, marble dust and white sand mixed with water, to which mixture is added either hog's lard, curdled milk or blood.

In A. D. 1280 at Rockingham Castle, England, melted wax was mixed with the mortar.

In A. D. 1324, in the work of King Edward II at Westminster, pitch was mixed with mortar.

The permanency of the Roman stuccos may be partially accounted for by the use of oil mixed with mortar. Although Vitruvius used hog's lard, an animal oil, the mortars have withstood the action of the centuries, and in places where freezing temperature occurs in winter and great heat in summer. However, the hog lard must have been very thoroughly emulsified by the action of the hydrated lime. Portland cement was unknown at that time.

In this connection I would like to suggest the following specification for stucco, the third or finish coat:

1 part Portland cement, 20 per cent (volume of cement) of hydrated lime, 3 parts coarse white sand. First dry mix the sand and cement and with this mix dry hydrated lime, turning each three times with shovels, rake while shoveling. Add water, turning and raking until the desired consistency is obtained. Then add 15 to 20 per cent of white oil petrol (Chesebrough Manufacturing Company of New York), the oil to be by weight in percentage to the weight of the cement. A gallon of oil petrol weighs 7½ pounds. Apply this mortar while the scratch coat is damp and as soon as the scratch coat is firm enough to stand the pressure of plastering. If it be desirable to tint the stucco, color the oil with any limeproof coloring matter, in proportion which by experiment with small samples is necessary to give the desired tint.

A white, non-volatile mineral oil is suggested for stucco and for mortar to be used in setting white marble or light-colored brick, on account of the color possibilities. For concrete where the color is not essential the heavy black bituminous oils to the light non-volatile petroleum oils are successful. They are cheap and their name is legion. Do not use oils containing organic matter, and positively avoid, at least for the present and until further experiments have been made, vegetable or animal oils, as they are liable to form an acid which in turn may disintegrate the concrete.

Lime, sand and animal oils have stood the test of centuries. Portland cement and animal oils have not yet had this opportunity. It is within the range of possibility that the test of time may prove contrary to the theory, and animal oils emulsified be found not dangerous; we will then consider a remark made by a very noted chemist: "If theory conflicts with the fact, we will have to change the fact."

SERUM THERAPY.

HOW SERUMS ARE EMPLOYED IN MODERN MEDICINE.

BY DR. FRITZ MEYER.

SERUM therapy is the treatment of disease by injecting into the blood the serum or watery part of the blood of an animal that has been made immune to that disease. Something similar to serum therapy appears to have been practised in antiquity. Mithridates king of Pontus fearing that he would be poisoned caused repeated small doses of various poisons to be administered for long periods to ducks the blood of which he drank, with the astonishing presentiment that it must contain effective antidotes to the poisons. The members of an ancient priestly caste in India allowed themselves to be bitten frequently by snakes which had been deprived of their poison glands. These priests claimed that their saliva thus acquired power to save the lives of persons who had been bitten by venomous serpents. These methods of treatment undoubtedly originated in the mind of some man of genius and were afterward practised ignorantly and according to tradition. Many centuries later a very important science was founded on the same basis.

In 1888 the French physiologists Richet and Héricourt inspired by Pasteur's theory of vaccination made the surprising discovery that rabbits survived injections of ordinarily deadly doses of certain bacteria if they had recently received injections of the blood of dogs which had been treated with increasing doses of the same bacteria until they had become immune to the action of doses normally fatal to dogs. In other words Richet and Héricourt discovered the possibility of communicating to another animal the immunity which Pasteur had succeeded in producing in the individual by repeated and increasing doses of the disease germ.

Two years later Behring expressed the conviction that acquired immunity is due to the presence of definite protective substances in the blood and that this condition can be transferred to other individuals by injections of serum.

Diseases of three classes are caused by bacteria. In the first class represented by diphtheria dysentery and tetanus the bacteria settle in one part of the body where they multiply and produce poisonous substances or toxins. The toxins enter the circulation of the blood but the bacteria do not. In the second class, represented by erysipelas puerperal fever pneumonia meningitis and diseases resulting from the infection of wounds the bacteria enter the circulation of the blood and invade every part of the body. Diseases of this class are called septic diseases and are very often fatal. In none of them has any true toxin or soluble poison been discovered. In the third class represented by typhoid fever cholera and plague both the bacteria and their toxins enter the general circulation.

Tuberculosis the disease which causes more deaths than any other has not yet been satisfactorily classified or explained. Although countless autopsies and other investigations are continually being made we do not know whether Koch's bacillus kills by producing toxins or directly by its multiplication in the blood and tissues of the body. As the forms of disease caused by bacteria differ so must the protective or immunizing influences which their germs develop in the blood. Ehrlich and Behring distinguish three classes of protective serums serums containing antitoxins or substances which neutralize the toxins of diseases of the first class antibacterial serums which check the multiplication of bacteria in diseases of the second class and serums which combine both of these properties and are efficacious in diseases of the third class. Hence, in view of our ignorance of the precise character of tuberculosis, it is not surprising that no efficient serum for that disease has yet been produced.

In France Austria and some other countries therapeutic serums are prepared in government establishments, called Pasteur institutes. In Germany a few great chemical firms have taken up the work. The serum is obtained from the blood of horses. The weight of the animal having been determined a minimum dose of a toxin or a bacterial culture is injected, according as the object is to produce an antitoxin serum or an antibacterial serum. The horse reacts to the injection with slight fever and other symptoms of ill health. After these have passed and the initial weight has been regained a second dose, twice as large as the first, is injected. In this way the injections are repeated and increased for a few months, until the horse finally fails to react to a dose large enough to kill 1,000 unimmunized horses. Three weeks after this condition of immunity has been attained about two gallons of blood are drawn from the horse's veins. After the blood has coagulated the clear serum is separated from the clot and its curative power is tested by injecting it into the circulation of mice guinea pigs monkeys and other small animals which have previously received injections of the toxin or the bacterial culture of the disease in question. This examination in the factory is followed by rigid official tests applied at the Ehrlich Institute in Frankfort. The serum cannot be sold for use on human beings until its potency has been officially determined and stamped upon the bottles. In the case of diphtheria serum the only one for which the system of gradation adopted can be regarded as final the unit is a quantity of antitoxin sufficient to protect a guinea pig against 100 times the normally deadly dose of the toxin of diphtheria. A serum which contains one unit of antitoxin in each cubic centimeter is called a normal serum and its potency is 1. A serum 1 000 times as strong is of potency 1 000 and so on.

The most successful results have been obtained with antitoxin serums especially in diphtheria tetanus and dysentery. In all of these diseases the serum exerts a curative action and abates the distressing symptoms. The statistics of diphtheria clearly demonstrate the importance of Behring's discovery. Only sixteen years ago the diagnosis diphtheria [illegible] in the family of the patient. Tracheotomy was frequently practised and many children died of suffocation. Now if the serum is administered promptly at the outbreak of the disease the suffering child becomes quiet the temperature falls and the pulse regains strength in eight or ten hours. The morbid accumulation is expelled from the throat sleep becomes possible and [illegible]6 hours later the child is convalescent. The result which nature can accomplish only in weeks by slowly producing antitoxin in the body of the patient modern science effects in a few hours by administering antitoxin which has been formed in the blood of horses.

The antibacterial serums which are employed to check the propagation of living germs and their dissemination through the body work in far less favorable conditions for every one of the host of microbes already produced is a fresh source of infection and even those which have been killed by the serum may cause serious organic injury. Hence these serums are efficacious chiefly or only when they are administered while the bacteria are still at the point of entrance and before they have become disseminated through the body. This is especially true in infected wounds puerperal fever pneumonia and splenic fever. For all of these diseases we possess serums which prevent the dissemination of the germs and protect the organism from fresh infection but it is seldom possible to cure a patient whose blood is already poisoned by the disease germs.

In diseases of the third class which includes typhoid fever cholera and plague the serum is required both to neutralize toxins and to check the multiplication of bacteria. The serum therapy of these diseases is still in its infancy but experience has convinced me that success will ultimately be attained.

In tuberculosis the prospect is less bright. No effective immunizing agent is yet known. A serum prepared by Marmorek has recently attracted much attention but its curative value must still be regarded as doubtful.

The statistics of diphtheria on the other hand show that the mortality in this disease has been reduced by the introduction of the serum treatment from between 30 and 41 per cent to 16 per cent and to between 2 and 6 per cent of the cases in which the serum is employed in the first two days of illness. In an epidemic of diphtheria in Berlin in 189[illegible] the mortality was 32 per cent in a hospital in which the serum was not used and only 8 per cent in a hospital in which it was used. Behring was fully justified in asserting that the serum treatment of diphtheria annually saves 20 000 human lives in Germany alone.

In every disease to which serum therapy is applicable the benefit derived from the treatment increases with the promptness of its application. The rule should be not to wait until the disease has appeared but to begin the serum treatment at the first sign of danger. Hence diphtheria serum is administered to all the children of a family in which a case of diphtheria occurs, tetanus serum is administered when a wound has been contaminated with earth (for the germ of tetanus lurks in the soil) and puerperal fever is prevented by injecting streptococcus serum at the first appearance of fever in childbed.

This employment of serums is destined to revolutionize all therapeutics. The more fully convinced of its harmlessness physicians become the more will they be inclined to employ it even at the risk of taking an unnecessary precaution. The excellence of the results obtained by this early employment of serums is due to the fact that all the toxins or bacteria that subsequently invade the body are attacked and destroyed immediately upon their entrance before they can reach important organs.

In contrast to this preventive serum treatment is the curative treatment employed after the disease has actually appeared. In the latter case the objects of the treatment are to check the multiplication of the bacteria and their production of toxins and to free the cells of the body from the toxins which have already been attached to them. It is not certain that the second object can be accomplished. There is good reason to believe that a cell once poisoned is incurable and doomed to death. But if the general organism is freed from poison it easily survives the loss of a few cells and replaces them by new ones. If the injury is extensive a scar is formed by the substitution of useless connective tissue for active cells but if the disease is quickly checked and the general vitality little impaired no permanent lesion is produced. Hence the action of serums is essentially preventive even when it appears to be curative for it is the protection of the tissues which have not yet been attacked that assures the replacement of the parts which have been destroyed.

The principal reason why the employment of serum treatment is so often delayed is to be found in the attitude of the public. The physician is often induced by the violent opposition of the family to wait until the favorable moment has passed. Many cases of diphtheria and puerperal fever are lost in this way. Furthermore the older physicians are not very familiar with the theory and practice of the method and are not inclined to employ it except in desperate cases. But these obstacles are gradually being removed as the increasing success of the continually improved serums gains new advocates of serum treatment.

The popular opposition to the new method finds some apparent justification in the unpleasant effects which it often produces. In about one case in five the injection of serum is followed in a week or so by eruption and itching of the skin slight fever and pains in the joints. These symptoms are justly attributed to the injection of serum but recent experiments prove that they are caused not by the antitoxin but by the action which certain substances formed in the human organism under the influence of the serum exert upon the albuminous constituents of the equine serum. The eruption is harmless and no patient has lost his life because of it.

Which diseases appear most likely to find effective serum treatment within a reasonable time? Unquestionably diphtheria and dysentery in both of which a very gratifying degree of success have already been attained. Although tetanus is a disease of the same class the toxin class serum treatment of tetanus has met with little success. An effective method cannot be developed until improved methods of diagnosis enable us to detect the disease before the beginning of the convulsions. So long as tetanus can be diagnosed with certainty only from the convulsions the majority of patients will die though treated with the best of serums.

In the second or septic class of diseases the situation is very similar. With the same serum results a hundredfold better are obtained by a good diagnostician than by a poor one and success in treatment must wait for improvement in diagnosis. A new field however has been opened for the employment of antibacterial serums in these diseases the field of local application. Recent investigations encourage the hope that peritonitis and meningitis can be checked in their first stages and quickly cured by the influence exerted upon the white corpuscles of the blood by antibacterial serums applied at the point of initial infection.

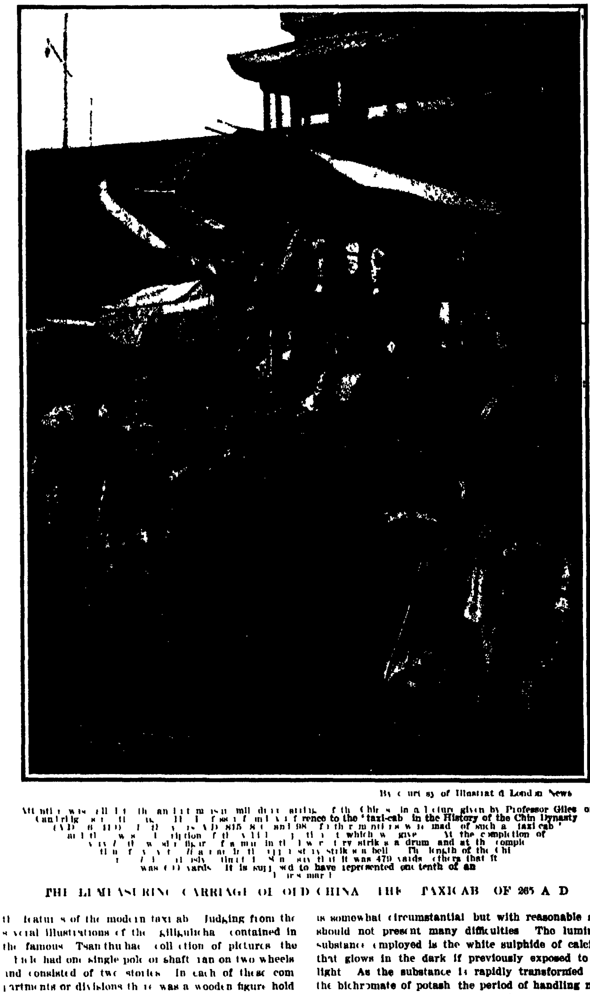
There is also good reason to hope that more efficient serums than those now known will soon be obtained by a double immunizing process for the diseases of the third class typhoid cholera and plague.

In tuberculosis however there is no immediate prospect of finding a method in any way superior to the rational and natural treatment with fresh air sunlight and abundant food. We must continue our studies until we learn more of the nature of the specific poison and the germ which produces it.—Umschau.

AN OLD-TIME "TAXI-CAB."

A CHINESE ANTICIPATION OF A MODERN INVENTION.

The taximeter cab or "taxi-cab," as it is called in New York, is quite the latest thing in the streets of our modern cities. And yet the old adage "there is nothing new under the sun" is peculiarly applicable to what we are all inclined to imagine is the product of the twentieth-century brain. An Oriental contemporary (Ostasiatische Lloyd) states that the Chinese can prove from one of their old and highly illustrated historical works that already in the eleventh century they had invented and were using a "kiligulicha" (or counting-mile drum-car), which possessed many of the features of the modern taxi-cab. Judging from the several illustrations of the "kiligulicha" contained in the famous Tsan-thu-hai collection of pictures, the vehicle had one single pole or shaft, ran on two wheels, and consisted of two stories. In each of these compartments or divisions there was a wooden figure holding a mallet in the right hand; these mallets were arranged to strike upon a drum in the lower story and upon a gong in the upper one. When the vehicle had traversed a certain predetermined distance, the lower figure struck the drum with its mallet, whereupon a cog-wheel made a revolution. When a distance of ten miles had been covered the upper figure struck the gong with its mallet. In some cases this Chinese taximeter car was also fitted with a compass which, owing to the total lack of landmarks and signposts, was of great value to the Celestial chauffeur of that time. A magnet was also provided; it was located in a small box and influenced a block upon which there was fastened a small jade or wooden figure, the outstretched arm of which always pointed due south.



By courtesy of Illustrated London News.

Attention was called to the ancient measuring drum carriage of the Chinese in a lecture given by Professor Giles of Cambridge [illegible] reference to the "taxi-cab" in the History of the Chin Dynasty (A.D. [illegible]) [illegible] A.D. 815 [illegible] and 98 [illegible] mention is made of such a "taxi-cab" and the [illegible] which we give. At the completion of [illegible] figure of a man in the lower story strikes a drum and at the completion of [illegible] upper story strikes a bell. The length of the Chinese li [illegible] some say that it was 470 yards, others that it was [illegible] yards. It is supposed to have represented one tenth of an hour's march.

THE LI-MEASURING CARRIAGE OF OLD CHINA: THE "TAXICAB" OF 265 A.D.

LUMINOUS PHOTOGRAPHS.

It is not difficult, even for a non-professional photographer, to make prints of his pictures having the peculiarity of a phosphorescent luminosity. The process is somewhat circumstantial, but with reasonable skill should not present many difficulties. The luminous substance employed is the white sulphide of calcium, that glows in the dark if previously exposed to the light. As the substance is rapidly transformed into the bichromate of potash, the period of handling must be curtailed as much as possible. According to a suggestion in the Photorevue, a solution of 30 parts of gelatine with ten times the volume by weight of water is made moderately warm and three parts of bichromate of potash and 12 parts of phosphorescent sulphide of calcium stirred in. With this mass a piece of common celluloid film is coated, the coating allowed to dry, and it is then exposed in a printing frame under the positive to the light, the non-coated side of the celluloid being in contact with the positive. The duration of exposure should be about the same as for a carbon print, and the development is likewise effected with the aid of warm water.

EXCAVATIONS AT CORBRIDGE.

Interesting results have been reached in the excavations at Corbridge, the Roman Corstopitum, which have been going on since 1906, and were described in a lecture to the members of the Carlisle Scientific and Literary Society by Mr. R. H. Foster, M.A. The site of the excavations is to the west of Corbridge, on the north bank of the Tyne, at a point where a Roman bridge carried Dere or Watling Street across the river. Unlike many Roman cities now overlain by modern towns, Corstopitum is situate in open fields, and by the aid of the foundations which have been uncovered an idea of the plan of the place, the direction of the streets, and the character of the buildings has been disclosed. They incline to the arrangements common to a civil community combined with features more definitely military. In 1907 a large and important building, probably a private residence, which had been many times altered and extended, was discovered on the rising ground to the northeast of the bridge. In its latest stage it comprised a series of eight apartments arranged between two corridors, and returned at both ends towards the south. The south corridor was warmed by a pillared hypocaust below the floor, divided midway in its length by a door, the threshold of which is still *in situ*. Hypocausts of larger size but rougher construction were found under two of the rooms at the west end of the building, and one of the eastern rooms was warmed by a series of boxed wall tiles. The wall plaster on some of the rooms had been repeatedly decorated in colors. On the south front of the house there was a cobbled terrace overlooking the river below, and on the north an enclosed courtyard paved with cobbles and containing an ornamental cistern, in which was found a fine piece of sculpture of a lion and a stag. On the plateau to the north, and possibly in the central district of the city, massive and important buildings were encountered. These bordered on a street about 36 feet in width, of three different levels, with corresponding drains and gutter stones. The buildings comprised a store in which, under a mass of burnt stuff, was discovered a quantity of pottery strewn as it had fallen from the shelves in separate heaps. The discoveries of 1908 were most important and interesting. Operations were commenced on the wide east to west street through the town. They revealed on the north side four structures, two of them strong buttressed barns or granaries at right angles to the street and almost 100 feet in length, the fountain, and a portion of a massive building comprising a number of chambers arranged about a quadrangle, the west range of which is 221 feet in length, and had for convenience been called the "Forum." Of the noteworthy finds the most remarkable was that of a hoard of gold coins, forty-eight in number, inclosed, together with a gold ring, in a piece of lead, and secreted 18 inches below the present ground level in a building of late date. The coins included examples of the reigns of Valentinian I., Valens, Gratian, Valentinian II., Theodosius, and Magnus Maximus, and ranged between the inclusive dates of 370-85. The coins were all in an excellent state of preservation, and with the exception of a find at Cleeve, near Cheltenham, in 1811, constituted the largest find of Roman gold coins made in Britain. The excavations of last year also produced a remarkable quantity of fragments of pottery, Samian ware being very abundant. Other kinds of pottery were also plentiful, ranging from Castor ware to rude black hand-made pottery. The work done during the past season (1909) has been more important, if in some respects less striking, than in 1908. Further explorations in front of the granaries has revealed the fact that the southern or street face of each had had a portico of four massive pillars. In the case of the east granary, this portico was probably of the same date as the main building, viz., about A.D. 140. The other portico was of later date, and was probably added in the time of Severus to a building which possibly dated as far back as A.D. 120.

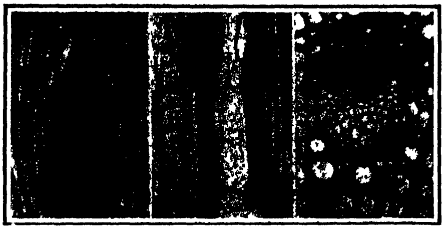
In a recent report of the Illinois State Highway Commission it is recommended, says Ferro-Concrete, after careful study and actual experience throughout the State, that all highway bridges on 50-foot span and under shall be constructed in ferro-concrete on the ground that this is "the most permanent form of construction known to engineers to-day." The report proposes that all highway bridges up to the span mentioned should be replaced within the next two years by ferro-concrete structures.

MINIATURE ART OF NATURE AND SCIENCE.

THE BEAUTY REVEALED BY THE MICROSCOPE.

BY DR V. GRAFE.

The improvements of the microscope of Leeuwenhoek opened to our view a world of miniature marvels and the subsequent development of the instrument and of the methods of microscopic research enable us now to recognize exceedingly fine and remarkable details in the anatomical structure of animals and plants and thus to gain an insight into the processes of life. Many anatomical preparations are masterpieces of technical art and skill showing all details which are resolvable by the microscope and which in many cases are present only in particular stages of the development of the organism. Every living cell is a microcosm in which an infinity of events is transpiring. In the first place there is the living protoplasm with its mysterious structure, then the nucleus which plays so important a part in reproduction and heredity and which possesses the power to subdivide itself according to regular laws after it has transformed itself into a structure of amazing complexity. All these wonders of life are laid bare by the knife of the expert anatomist and are made more conspicuous by the application of various dyestuffs each of which stains only certain parts of the cell. Hematoxylin for example colors only the nucleus and thus brings it into prominence. The phenomena of the division of the nucleus are made distinctly visible by a triple staining with safranin, gentian violet and orange yellow. With the instrument known as the microtome it is possible to make a long series of successive thin sections of an object which has previously been saturated with paraffin by a complicated process. The preparation is imbedded in Canada balsam to protect it from external influences.



Left hand picture—Terminal bud. Middle picture—Longitudinal section of stem showing water tubes of various forms. Right hand picture—Cross section of a vascular [illegible] highly [illegible]. The thick walled dark cells at the top are bast cells [illegible] and the large [illegible] at the bottom [illegible] tubes.

FIG. 1.—THREE MICROPHOTOGRAPHS OF THE WATER WEED (ELODEA CANADENSIS).

Microscopic preparations are absolutely necessary for the study of natural history and it is also necessary to give the student opportunity to examine them very thoroughly for the unpractised eye often fails to observe important details, at the first glance, unless attention is especially called to them. For this reason it has long been customary to make drawings, which can be studied at leisure of objects as seen with the microscope. But this method is open to serious objection. Although great improvements have been made in the method of making such drawings it is still impossible to reproduce every detail of the microscopic picture. Furthermore every such drawing is affected by the personal error of the draftsman [illegible] two observers see the same object alike. During the last ten years attempts have been made to solve the problem with the aid of photography.

Until recently only special students of natural history have experienced any great need of microscopic objects or representations of them but with the increasing popularity of the natural sciences this need is becoming felt by the schools and the general public. Artists also find here an inexhaustible source of inspiration as Haeckel and Boelsche have pointed out. It is only necessary to glance at the drawings of Hinterberg the first eminent artist to enter this field, or to examine some of the botanical and zoological objects themselves, in order to appreciate the interesting problems which are here presented to the draftsman, the sculptor and the goldsmith. Many microphotographs of these objects contain ideal designs for carpets, wall paper, jewelry and embroidery.

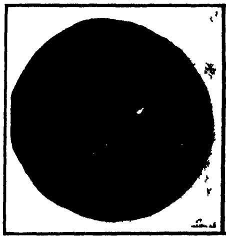


FIG. 4.—CROSS SECTION OF EXOGENOUS ARISTOLOCHIA.

Showing vascular bundles arranged in a circle.

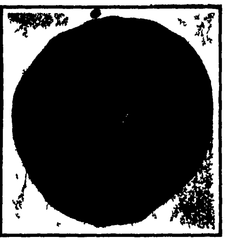


FIG. 5.—CROSS SECTION OF THREE YEAR OLD STEM OF LINDEN.

Showing the annular rings and encircling ring of bark.

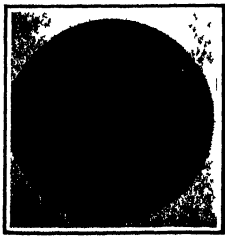


FIG. 2.—THE TIPS OF A ROOT.

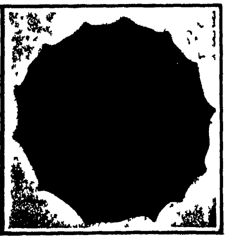


FIG. 3.—CROSS SECTION OF ENDOGENOUS DRAGON TREE.

Showing vascular bundles distributed irregularly.

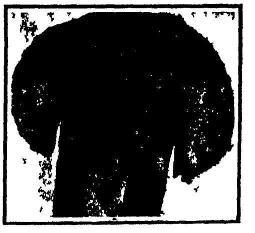


FIG. 6.—ERGOT.

The making of such photographs is not easy. The sections which are always difficult to make in the case of embryos, leaf buds and numerous other objects must for this purpose be executed with especial care in order to give prominence to the particular detail which it is desired to reproduce. The staining requires special knowledge and skill which differ with almost every preparation. Not the smallest hair or grain of dust must be permitted to mar the distinctness of the picture. In photographing the microscope is placed horizontally and in exact alignment with the bellows camera and the source of light—self-regulating arc lamp. The degree of enlargement must be chosen with careful reference to the sharpness of the picture. The time of exposure depends on the thickness and transparency of the object. It is also necessary to employ taste and discrimination in the choice of objects for while the draftsman can correct nature here and there the camera reproduces every defect with ruthless accuracy. The photographic operations require good scientific training as well as technical skill in order that the anatomical and photographic details may harmonize. From the negatives are made positive lantern slides which can be projected on screens to exhibit all the microscopic details to large numbers of spectators.

The photographs here reproduced were made in Hinterberg's laboratory from objects prepared by Dr Jencic of the University of Vienna. One of the pictures (Fig 5) shows a cross section of a linden stem. In the center and occupying most of the section is the vascular tissue of woody cells of large diameter which is called the xylem and serves for the transport of water. Surrounding this is the thin cambium layer in which the growth of the stem in thickness takes place. Next comes another vascular layer the phloem in which flow the currents of elaborated sap and on the outside is a layer of long and thick bast cells which give flexibility and toughness to the stem. The water conduits of the xylem are formed by the coalescence of cells in the young roots, stems, branches and leaves into long tubes the walls of which are stiffened by many rings, spiral and interlacing ridges and which extend from the roots to the leaves.

The vessels of the phloem which serve for the conveyance of elaborated sap are of very different construction. They are called sieve tubes and are formed by the partial coalescence of cells the transverse walls of which have not like those of the component cells of the water tubes nearly or quite vanished but have merely become perforated like sieves. The sieve tubes begin in the leaf where together with the water tubes they form the so-called veins and like the water tubes they continue down through the leaf stalk twig branch and stem or trunk to the root. The sieve tubes and water tubes constitute the vascular bundles. The coarse water tubes are nearer the axis the fine sieve tubes nearer the bark. The two great classes of flowering plants endogens or monocotyledons and exogens or dicotyledons are distinguished from each other by the structure and arrangement of the vascular bundles. In endogens which include palms lilies etc the vascular bundles are very numerous and are distributed irregularly through the entire cross section of the stem though most closely near the circumference (Fig. 3). New bundles appear among the old ones as the stem increases in size. In exogens (Fig. 4) which include our common timber trees and many other plants the vascular bundles are arranged in a circle which increases in size with the stem. Between the sieve tubes and the water tubes is a ring of soft cells the cambium which continually increase in number by cell division during the growing season from April to September and thus cause the stem to increase in girth. The cambium layer surrounds the wood and is surrounded by the thin bast layer which lies immediately beneath the bark. The wood of our common forest trees when sawn crosswise shows a number of concentric rings from which the age of the tree can be determined for each ring represents the result of the activity of the cambium during one annual period of growth. The new wood formed in spring contains more numerous and larger tubes than the wood formed in autumn. The wood of spring is deposited next to the wood of the preceding autumn and the sharp contrast between them produces the conspicuous annual ring. Most tropical woods being endogenous show no annual rings and are thus easily distinguished from native woods.

The contrast in the manner of growth of aerial and underground parts of the plant is also instructively shown by microphotographs. The terminal bud is composed of a number of leaves and scales of which the older and harder inclose and protect the younger and softer. This formation is especially well marked in the water weed (*Elodea Canadensis*, Fig. 1). The rootlets on the contrary grow directly from the interior of the root. The tip of every root is protected by a cap of harder cells and contains starch grains, the weight of which according to Haberlandt causes the root to grow downward. These starch grains are organs of equilibrium like the otoliths or grains of carbonate of lime in the ears of higher animals.

Another interesting photograph (Fig. 6) shows a section of the pileus or reproductive part, of ergot or smut a poisonous fungus which grows on the grain of rye and has caused many deaths. The bottle-shaped glands are filled with the black spores which give smutty rye its characteristic appearance.

These few examples may serve to give some idea of the wonders which are revealed by the microscope and which it is now possible to exhibit to great numbers of spectators with the aid of photography and the projecting lantern.—Translated for Scientific American Supplement from Reclam's Universum.

HALLEY'S COMET.

SUGGESTED OBSERVATIONS.

The Astronomical and Astrophysical Society of America through its comet committee is soliciting co-operation in the observation of Halley's comet at the present return and has prepared a circular letter of advice that has been widely distributed among observatories with regard to such observations. A copy of this circular will be sent to any astronomer who may desire to use it upon request being made to the chairman of the committee Prof. G. C. Comstock Washburn Observatory Madison Wisconsin. As many astronomers and other observers of Halley's comet will be interested in the suggestion made by the committee the circular is here reprinted in a slightly abridged form.

It is desirable that the position of the comet be well observed during the entire period of its visibility and it seems probable that extra meridian observations will be secured in sufficient number without especial solicitation. In view however of possible large perturbations arising from the close approach of the comet to Venus on May 1 and to the earth on May 18 meridian observations are especially desired during the period in which the comet is sufficiently bright for that purpose. An examination of the amount and character of these comet perturbations and their adaptability to a determination of the mass of the planets producing them has been undertaken by Profs. Leuschner and Crawford and in case the conditions prove favorable the meridian determinations may well be supplemented by heliometer observations of the positions of the inner planets with the view of a possible determination of the mass of the comet itself.

The close approach of the comet to the earth promises unusual opportunity for a study of the physical conditions that obtain in such a body and as an indispensable basis for such study the committee recommends a photographic campaign as long and as nearly continuous as possible. The comet's close proximity to the sun's direction at the time of maximum brilliance imposes serious limitations upon this programme and widely extended co-operation will be required throughout the whole circuit of the earth if this ideal of a continuous photographic record is to be even remotely realized.

About one third of the earth's circumference in longitude is covered by the Pacific Ocean within which there is known to exist no observatory with proper facilities for celestial photography. To fill this gap at least partially the committee aided by a grant from the National Academy of Sciences proposes to send to the Hawaiian Islands an expedition to photograph the comet during the period of its greatest brilliance.

The ends to be served by these photographs and others obtained elsewhere are as follows:

To give a permanent record as continuous as possible, of the phenomena and changes (1) in the tail of the comet with special reference to outgoing masses (2) in the head and nucleus of the comet particularly as to the formation of envelopes and jets.

The following suggestions as to procedure and precaution in making the photographs have been formulated by Prof. Barnard.

PHOTOGRAPHY OF COMETS

One of the greatest difficulties in photographing the average bright comet is its proximity to the horizon and consequent projection on a more or less dawn or twilight sky. The effect of this illuminated background with any considerable exposure is to fog the plate to such an extent as either to ruin it or to prevent a proper development of the image of the comet. A difference of three or four minutes in the duration of exposure when the sky is brightest may make a success or a failure of the picture. It is impossible to establish fixed rules as to when the exposure should stop or begin so much will depend upon the condition of the sky the position of the comet the kind of lens the rapidity of the plates etc. The best rule is that of the judgment of the observer at the time and this can only be derived from actual experience in the work.

The plates should be backed with the following to prevent halation. Cook two pounds of white sugar in a saucepan without water until nearly in the caramel stage then add one pound of burnt sienna. Cook a little more (but not to the candy stage) stirring well. Finally add about one half an ounce of alcohol to each pint of backing as a dryer. This backing will keep indefinitely. When it is too hard moisten it with a little water. This is to be applied to the back of the plate as a stiff paste with a broad camel's hair brush and should be applied just before using. A piece of old newspaper pressed upon this will prevent its being rubbed. The face of the plate should be very carefully dusted with a broad camel's hair brush after it has been placed in the plate holder. The camera tube should also be frequently wiped out with a damp cloth to avoid dust. Before developing remove the backing with moist absorbent cotton. If a little remains on the plate it will not injure the developer. In removing the backing be careful to shield the plate from the dark room light. Do not wet the surface of the plate before pouring on the developer as it may cause air bubbles on the film; swab it carefully with absorbent cotton at the beginning of development. Develop until the plate is almost opaque to the ordinary developing light. Fix for twenty minutes or more in the ordinary fixing bath (frequently made new) to which has been added a teaspoonful of sodium bisulphite to prevent discoloration.

Lumière Sigma dry plates are recommended because of their rapidity. Seed 27 Gilt Edge and Cramer Crown are both beautiful plates, but are not now so rapid as the Sigma.

Hydrochinon developer gives a good strong negative and for astronomical work is excellent. Rodinal in a weakened form say 1/60 or 1/70 of water with a longer development will give a soft and more transparent negative especially suited for showing the details of the head of the comet on large-scale photographs.

The doublet or portrait lens such as is made in America by the Brashear Optical Company and the Alvan Clark Corporation on account of its wide field, is the best form of instrument for showing the general features of the comet and its tail and especially for following any outgoing masses that may appear in the tail. One of about 6 inches (15 centimeters) aperture will be the most generally used because of the expense of such instruments. It should be supplemented by several smaller lenses. A "lantern" lens of 1 3/5 inches (4 centimeters) aperture and about 6 inches (15 centimeters) focus made by McAllister, of New York is recommended for showing the extent of the tail. The cost of one of these lantern lenses is seven dollars. It gives a good field of twenty to thirty degrees, especially when diaphragmed down to 1 inch. It is extremely quick for comet work. Its focus should be carefully determined by star trails.

In comet work it is important in all these lenses that the camera should be so adjusted on the mounting with respect to the guiding telescope that the head of the comet can be displaced to one side of the field to secure a greater extension of the tail. Two of the small lenses may be so arranged by a mutual adjustment as to cover the full length of the tail even though it should be fifty degrees long or more. Although it would thus be in two sections—the head and part of the tail on one plate and the rest of the tail on the other—there would be no serious objection if the whole tail could thus be secured. The large reflectors will be of the utmost importance in dealing with the detail and structure of the head and envelopes as has been recently shown at Greenwich.

Until something further is known of the spectrum of the comet it would be unwise to attempt to give any specific directions as to the duration of exposure required with any telescope. Daniel's comet of 1907 and Morehouse's of 1908 were very different in respect to their photographic activity. The latter was relatively many times more actinic in its light and hence required much shorter exposures to show the same strength of tail. This information must come from actual experience with the comet. It would seem however that the circumstances of the comet's visibility when brightest will make short exposures necessary.

The committee will be pleased to receive from every astronomer who may co-operate in the matter copies (glass positives) of his negatives of Halley's comet, and it will undertake the comparison and discussion of the material thus collected.

SPECTROSCOPIC OBSERVATIONS

For spectroscopic observations of the comet the committee makes the following suggestions, formulated by Prof. Frost. While it may be possible to make visual observations of the comet's spectrum with ocular spectroscopes attached to large telescopes it is likely that most of the photographic records of the spectrum will be obtained by the objective prism or the slit spectrograph and reference will be made in what follows to the use of these two types of instrument.

These methods of observation are mutually complementary, for the accurate measurement of wavelength effect of motion in the line of sight and analysis of structure of lines or bands (if sufficiently sharp), the slit spectrograph has all the advantages, but for study of distribution of elements in different parts of the comet, and for reaching faint details the prismatic camera, or objective prism, with its much greater light-power is essential. The prismatic camera may be employed with a fair possibility of success, when the comet's brightness is equivalent to that of a ninth or tenth magnitude star, the slit spectrograph cannot be hopefully applied before the comet is two or three magnitudes brighter. The size and kind of telescope employed, of course, make such statements relative rather than absolute, and uncertain at best. Too much here depends upon the comet; if its light is chiefly reflected rather than intrinsic, and the continuous spectrum is predominant, then the comet will have to be much brighter for satisfactory spectroscopic analysis than if the light is largely intrinsic and concentrated at half a dozen points in the spectrum Comets showing sudden and marked fluctuation in size or brightness are likely to exhibit changes in the bright band spectrum

(1) Prismatic camera or objective prism

The camera should be a doublet of large annular aperture, 1/4 or 1/5 Useful observations could be secured if the linear aperature is as small as 4 or 5 inches (10 or 12 7 centimeters) The objective prism should be of small angle, perhaps 10 deg or 15 deg, if an additional prism is available for the period of the comet's greatest brightness its angle should be about three times that of the smaller prism If the doublet is of comparatively short focus, as is likely to be the case, it will be found to be quite sensitive to focus, and separate exposures will be needed for the blue-violet region and the yellow green region Optical parts transparent to ultra violet would be useful as there may be some important bands of shorter wave length than λ 3883

It is very desirable to photograph the spectrum of a star before or after the comet placing the star at such a point on the reticle of the guiding telescope that the stellar lines may serve for comparison

Prof Pickering suggests that an interesting observation would be to photograph the spectrum of a star when seen through the bright portion of the tail, to see if dark absorption lines could be detected

(2) Slit spectrograph

A small spectrograph will be a very useful attachment to a photographic doublet as described above It need not be complicated and its dispersion may be small Apparatus for producing a comparison spectrum is not essential for a neighboring star of the first type may be brought upon the slit and its spectrum impressed above and below that of the comet With one thread of the guiding telescope or finder, movable the star can be placed so that its spectrum will fall on the slit as desired The identity of the cometary band can be thus established better than with the objective prism After spectrograms of the comet have thus been obtained it will also be desirable to obtain plates with the slit as narrow as feasible in order to detect duplicity or complexity of the lines or bands

Observations with powerful stellar spectrographs of the types in use for determining radial velocities will doubtless be made as soon as the comet's brightness permits, but this is likely to be disappointingly late on account of the heavy loss of light in such instruments The fixed equipment of these instruments will determine their operation by their regular observers

PHOTOMETRIC AND POLARISCOPIC OBSERVATIONS

Photometric and polariscopic observations of the comet should certainly be made although they will doubtless occupy a position of subordinate importance The suggestions of the committee in this respect are formulated by Prof Pickering, as follows

A great variety of methods may be employed for measuring the light or amount of polarization of the comet It is suggested that astronomers undertaking this problem should correspond with the chairman of the committee, in order that uniform methods may be employed throughout by different observers The plans proposed below may require modification according to the instruments available

A direct estimate by Argelander's method of the entire light of the comet as seen by the naked eye or in the smallest telescope with which it is visible may have a certain value to observers in the future although large systematic errors are to be expected in such estimates

It is doubtful if photometric measures of the nucleus of the comet will have much value as the results will probably be greatly affected by the coma and will differ with different photometers and telescopes If the nucleus be distinctly stellar it may be compared directly with an adjacent star by means of a double image photometer The effect of background would thus be eliminated Direct measures with a Zollner photometer or similar instrument would probably have but little value owing to the effect of the coma Any series by the same observer with the same instrument would be valuable by itself and the observations by different persons and different instruments might be subsequently adjusted for systematic differences

The measures described in Harvard Circular 68 showed that the absorption of light by the tail of *comet 1902b* was certainly less than a tenth of a magnitude Similar measures should be made of Halley's comet A double image photometer is indispensable for these measures also to eliminate the effect of background

The light of different portions of the tail of the comet may best be measured by the following method Take two photographs at the same time with similar instruments using the same kind of plate and developer and giving equal exposures taking one in focus and the other out of focus so that the images of the stars shall appear as circles two or three millimeters in diameter Make similar enlargements of the two plates interposing screens of perforated brass Measures of the opacity of the resulting circular images of different portions of the comet on one plate may be compared with the images of stars the magnitudes of which are known as photographed on the other plate The effect of the light of the sky or of twilight may thus be eliminated and the light of the comet compared with that of a star of known magnitude spread over a standard area The two photographs may also be compared directly with a suitable photometer

Messrs Barnard and Frost, having also the benefit of Mr Parkhurst's opinion suggest as an alternative and possibly better method the extra focal use of a single camera The intensity of the extra focal cometary image could be reduced to the focal plane as accurately as for the star images The relative values on different nights would always be correct

Useful suggestions for the photometric observations of the comet may be derived from a paper by Dr Rosenberg upon photometric observations of the Morehouse comet contained in the Astrophysical Journal for November

The polarization if any of the comet's tail may best be studied by photographs taken with a camera having a double image prism placed over the lens The prism should be turned so that the two images are perpendicular to the direction of the sun The two images of an unpolarized object should be alike if the correction for color is the same for both otherwise it will be necessary to take a second photograph turning the prism 180 deg If the light is polarized one image may be fainter than the other as in similar photographs of the solar corona Measures may be made as described in the preceding paragraph

Bands will doubtless be seen if the comet is examined by means of a Savart's polariscope or similar instrument but it is in that case difficult to distinguish between slight polarization of the comet and the strong polarization of faint sky light

MINOR NOTES

The following titles may be specified as minor matters not included above but which may in some circumstances become of importance viz

The head of the comet should be carefully examined for traces of phase Possible disturbances may be found in the comet due to its close approach to Venus on May 1st and to the earth on May 18th A transit of the earth through the comet's tail is possible at or near the latter date and if such should occur a meteoric shower should be looked for and observed with reference to a determination of the meteoritic particles their frequency size etc Resultant disturbances of the electric potential of the earth's atmosphere are possible and the co-operation of meteorological observers and especially of national weather bureaus is earnestly desired in this connection

Although the amount of refraction experienced by light in transit through a comet is known to be very small it seems desirable to make investigation of the matter photographically with long focus telescopes The position of a sufficiently bright star near the nucleus or in the brightest part of the edge of the tail should be referred to a group of more distant ones and the resulting position of the star compared with that resulting from another plate exposed after the comet has left the star

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THE OPTICAL METHOD OF STUDYING IMMUNITY TO BACTERIAL DISEASES.

By Dr H A Gins

Certain substances possess the property of rotating the plane of polarization of light Sugar is one of these substances and the percentage of sugar in a solution is estimated in sugar refineries by measuring the angle through which the solution turns the plane of polarization of a beam of polarized light which is passed through it

Abderhalden has recently extended the field of usefulness of the polaribeter to the study of the changes which take place in the blood during the formation of the substances which the organism produces as antidotes to bacteria or poisons, which have entered the blood, and has obtained very promising results

Some of Abderhalden's experiments were made on peptones These are the comparatively simple but still very complex, products of the first stage of decomposition of albuminous or proteid substances The chemical constitution of peptones is not yet accurately known, but it is possible to split them up into still simpler compounds, the amino acids, which are more thoroughly understood

In general, when a solution containing a peptone and a *ferment* is placed in the polarizing apparatus the plane of polarization is rotated by an amount which does not, at first, remain constant, but either increases or decreases Ferments are complex substances which possess the power to decompose, or subdivide, other compounds Numerous ferments are found in the animal organism One is the pepsin of the stomach, which digests albumen, a second is diastase, which converts starch into sugar, and there are many others. The rotation of the plane of polarization of the beam of light, which traverses the mixture of peptone and ferment, indicates the precise manner in which the ferment acts on the peptone For example, let us suppose that a certain peptone, *abc*, which turns the plane of polarization [illegible] deg. to the right, is known to be composed of the three amino acids, *a*, *b* and *c*, of which [illegible] plane of polarization 5 deg. to the right while neither *b* nor *c* alone exerts any rotary action One ferment may separate the peptone *ab* into the two parts *a* and *bc* a second ferment may yield the two products *ab* and *c* a third may resolve the peptone into the three amino acids *a* *b* and and so on As a rule each of these reactions will produce a different change in the amount by which the plane of polarization is rotated by the mixture Hence by observing this rotation the parts into which the peptone is divided by the ferment can be determined and the nature of the ferment can be deduced The assumption made in this hypothetical case has been confirmed by Abderhalden's researches

In order to secure absolutely unequivocal result Abderhalden used in his first experiments a peptone obtained from milk and employed as a ferment the liquid extract expressed from yeast which was known to separate that peptone into certain definite amino acids He next mixed the blood serum of normal rabbits and dogs with this peptone and found that the position of the plane of polarization of light which traversed the mixture remained almost unchanged This result proved that the normal serum exerted little, if any decomposing action upon the peptone A very different result was obtained when the peptone was mixed with serum obtained from animals which had been treated with hypodermic injections of the same peptone

Recent researches have shown that animal organisms possess natural means of defense against the attacks of invading disease germs and their poisonous secretions or toxines If a man for example has become infected with typhoid bacilli his body reacts to the infection by producing substances which are poisonous to those bacilli and which confer immunity to typhoid for a long period often for life The blood of this man when mixed with typhoid bacilli even outside of the body coagulates them and makes them harmless but no such property is exhibited by the blood of a person who has never been infected with typhoid

In like manner, the blood serum of the rabbits and dogs, which had received hypodermic injections of the peptone, acquired the power to act as a ferment upon that peptone This property was made evident by the change in the rotation *of the plane of polarization of* a beam of light passing through the liquid This action ceased when the mixture was heated to 149 deg F showing that the protective or immunizing power of the serum is destroyed by heating to that temperature

These experiments extend the hope that we shall soon be able to study by a comparatively simple method the processes which take place in the blood of an organism infected with bacterial disease and which have hitherto required for their observation methods which are difficult tedious and yet imperfect —Umschau

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THE EFFECT OF LIGHT AND ULTRA-VIOLET RAYS

A series of experiments on the action of light and ultra violet rays upon the red corpuscles and pigments of the blood has been made by Hasselbalch in the laboratory of the Finsen Institute of Copenhagen Starting from the fact established by an earlier research that exposure to ultra violet rays diminishes the capacity of blood to absorb and evolve oxygen Hasselbalch proceeded to determine the nature and conditions of this and analogous effects excited by rays of short wave length on certain derivatives of hemoglobin He also studied the liquefying action of light on blood and the action of certain photobiologic sensitizers on blood pigments and corpuscles

The experiments were performed with fresh defibrinated ox blood and the washed corpuscles obtained from it and also with solutions of oxyhemoglobin The source of radiation was a Kromayer mercury vapor lamp operated with 3 6 amperes and 120 volts which furnished rays of all wave lengths between 600 and 220 μμ (The visible spectrum extends approximately from 700 to 400 μμ The symbol μμ denotes one millionth of a millimeter) In some experiments the extreme ultra-violet rays were cut off by placing before the quartz window of the lamp a plate of ordinary glass, or one of "Uviol glass which eliminates all waves shorter than 310 μμ or 250 μμ, respectively

The experiments proved that the natural coloring matter of the blood is converted by the rays of the Kromayer lamp into metahemoglobin which subsequently forms hematin and other products of polymerization. The presence of oxygen is necessary for this reaction as deoxidized hemoglobin is not affected by the rays. The strongest action is exerted by rays of wave length 310 μμ. The reaction takes place at the same rate whether the oxyhemoglobin is in solution or in the red blood corpuscles.

Metahemoglobin exposed to the rays in vacuo is converted into hemoglobin but in darkness oxyhemoglobin is formed by the action of the liberated oxygen.

Hematin is reduced by the rays to hemochromogen from which it is re-formed in the dark.

Oxycarbonated hemoglobin is partially converted into hemoglobin by the rays and is re-formed in the dark.

Both in air and in vacuo the red corpuscles dissolve under the influence of the rays. The greatest effect is produced by wave lengths shorter than 310 μμ, but the rays of the visible spectrum exert an appreciable solvent action.

All the actions exerted by the rays in the presence of air are accelerated by the addition of color sensitizers but in vacuo these substances accelerate only those reactions in which oxygen is liberated. A sensitizer for the reactions studied in these experiments is a substance which strongly absorbs light and is easily oxidized.

HOW TO PROVE THAT YOU REACHED THE POLE.

THE SCIENTIFIC PREPARATION AND EXAMINATION OF RECORDS.

BY J HAMMOND SMITH, UNIVERSITY OF PITTSBURGH.

Explorers of all ages have generally carried with them the best obtainable data and instruments for the ready determination of geographic position. These include maps and descriptive data which are invaluable for showing the relative positions of physical features of the land and bodies of water and instruments for the determination of latitude, longitude and elevation above sea level.

In polar expeditions the maps alone will serve the explorer until he reaches unknown lands or waters unless he desires to find his position at sea or check his maps or other data. But as he travels onward into unknown regions it will be necessary for him to determine his position by means of instruments. He can determine his elevation by observations on the pressure of the air which are made by means of the aneroid barometer or by the temperature of boiling liquids. The most important observation however is the one which determines his latitude. This observation is made by measuring the altitude of a celestial body generally the sun as it crosses the observer's meridian or at its highest or lowest position in the heavens when it can be seen. The instruments used for this observation are a pocket sextant a very small and compact instrument yet one of considerable accuracy when properly used and an artificial horizon which is simply a plate of black glass with level vial attached. The angle between the sky image of the sun and the image reflected from the artificial horizon is measured by means of the sextant. The declination or angle between the plane of the equator and the position of the sun must also be known and can be determined for the time of observation from the data of the solar ephemeris which the explorer must carry with him.

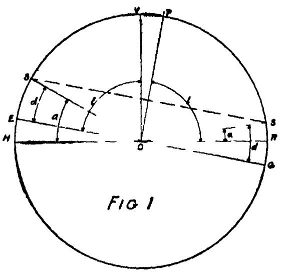

FIG 1 POLAR SECTION OF THE CELESTIAL SPHERE

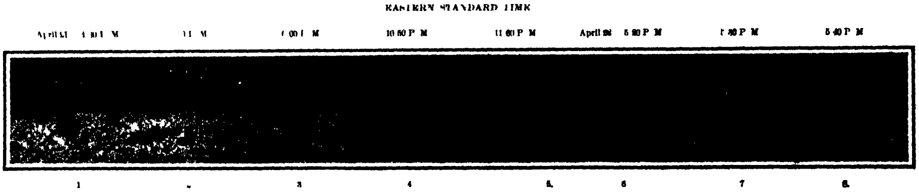

FIG 2 PRINCIPLE UNDERLYING PHOTOGRAPHIC PROOF

In order to explain the methods of taking and reducing observations let Fig 1 represent a polar section of the celestial sphere taken through the position of the observer. Then O represents the position of the observer, Z his zenith and HR his horizon, EQ the equator, P the pole and S and S′ the positions of the sun at its greatest and least altitudes respectively or at positions on the observer's meridian. The altitudes being represented by a and a′ the declinations by d and d′ respectively and the observer's latitude by l.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1 PM	NOON	85 41	33	0 4 48	8 44	87 38	97
5	2 30		2 30	11 5	4 56	9 30 4	88 35	94 8
7	0	0 PM	9 0	3	4 88	0 2	88 4 8	91 3
9	0	NOON	00 0	11 16	4 41	3 33	83 22	44
2	4 AM	NONE	0 0	36	4 10	44 48	88 47	15
2	2 5 PM	—	—	2 0	4 2	11 33 7	89 38 3	8
2	0 0	—	—	3 6	4 3	11 48	30 0	0
2	6 0 AM			2 8	4 4	2 8 24	83 53 5	5

TABLE I

Then

$$l = 90 - (a - d) \text{ or}$$
$$l = 90 + (a' - d')$$

In order that we may understand the methods of using these equations let us assume that we have the explorer's data before us as shown in Table I.

For example the observation of April 15th was taken when the sun was observed to be highest in the heavens. This was at 2 30 P M eastern Standard time. The altitude observed at this time was 11° 51′ and the correction for atmospheric refraction and parallax found from tables was 4′ 26″ making the corrected altitude $a = (11^\circ\ 51') - (4'\ 26'') = 11^\circ\ 46'\ 34''$. The declination of the sun found from the tables of the solar ephemeris was 9° 50′ 4″. Then by use of the equation

$$l = 90 - [(11^\circ\ 46'\ 34'') - (9^\circ\ 50'\ 4'')]$$
$$l = 90 - (a - d)$$

The latitude = 88° 3′ 0″

The longitude of the observer's position may be determined by noting the time at which the sun crosses the meridian. For instance if the explorer's chronometer is set on eastern standard time (mean time of the 75th meridian) and the sun is observed to reach its greatest altitude at 1 40 P M the longitude of the place is

$$75 + 15^\circ \times 1\ 2/3 = 100 \text{ west of Greenwich}$$

But the importance of exact longitude grows less as the distance from the pole decreases. At the equator one (1) degree of longitude is equal to about 69.25 miles while at 200 miles from the pole it is about 3.49 miles and at the position shown in observation of April 19th which is 44 miles from the pole one degree equals only about 0.77 mile.

If it be assumed that the observation of April 19th were taken when the sun was on a meridian 8° in longitude ($t = 8^\circ = 6.16$ miles eastward or westward) from the position of the observer, we obtain the following results,

$$\tan D = \frac{\tan d}{\cos t} \text{ from which}$$
$$D = 11\ 0\ 7 \text{ then}$$
$$\cos(l - D) = \frac{\sin a \sin D}{\sin d} \text{ or}$$
$$l - D = 7[illegible]\ 0\ 4 \text{ and therefore}$$
$$l = 89\ [illegible]0\ 9$$

Giving the position as 11′ or about 1.25 miles farther from the pole than the result given in the table which was found by assuming the sun to be on the observer's meridian at the time of observation. This clearly shows that large errors in longitude or time can have little effect on practical determinations of latitude in the polar regions.

By a careful examination of the foregoing observations (all assumed) and the latitudes deduced the reader will be convinced that it is possible to fake observations. Therefore when an explorer returns with his narrative of having reached the pole a complete and perfect set of observations and a large collection of photographs taken at random do we thereby have complete proof that he has actually reached the pole? If the explorer's veracity is omitted from the deduction we think the proof is far from being complete. And it is none the less certain that it is very difficult to make it complete.

As a possible aid to the proof the writer suggests the following method.

When the explorer has closely located the position of 90° latitude by means of his sextant he may bring his camera into use to take a systematic set of photographs of the whole visible horizon with the sun showing its altitude and casting shadows of objects arranged in the foreground around the camera.

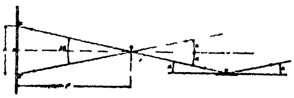

Fig 3

FIG 3 –USE OF ARTIFICIAL HORIZON IN AIDING PHOTOGRAPHIC PROOF

Sketches 1 to 8 in Fig 2 show the principle of this method. The photographs should be taken in such a manner as to include a complete panoramic view of the horizon with the pictures either continuous or overlapping. The artificial horizon may be used as a possible aid in this photographic proof. It may be leveled in front of the camera in the proper location to reflect the image of the sun on the photographic plate. Fig 3 will serve to make this principle clear. *H* represents the photographic plate, *O* the optical center of the lens, and *Z* the artificial horizon. Then, if the altitude of the sun is *a*, it is evident that the angle between the direct and reflected beams will be 2a and can be measured with reasonable accuracy on the photographs by means of one of the following methods

(1) $\frac{A}{2F} = \tan a$ In which A is the distance between the images of the sun in the sky and in the artificial horizon on the photograph and F is the focal length of the lens

(2) $\frac{L}{360} = S$ In which L is the total length of the panoramic photograph and S is the distance on the photograph which represents one degree For instance

If $L = 36$ inches $S = \frac{36}{360} = 0.10$ inch or 1/10 inch on the photograph represents one degree

If $A = 2.42$ inches on photograph 2 Fig 2 then $2a = \frac{2.42}{0.10} = 24.2$ or $a = 12.1° = 12° 6$

If the artificial horizon is not used a straight line representing the average horizon may be drawn and the altitude of the sun measured directly from this line

Photographs showing the sun must first have a quick exposure with small aperture or a colored screen may be used over the lens to get the images of the sun then to get the details of the picture an ordinary exposure is made with lens shielded from the sun and the artificial horizon covered The sun with shadows must show in at least three of the photographs The largest possible number of photographs should be taken in order that a large number of the plates may be developed after the return of the expedition

HYDRAULIC MOTORS AND PUMPS.

PROF. HELE-SHAW'S LATEST INVENTIONS.

PROF HELE-SHAW F R S, has lately patented some interesting improvements in connection with a hydraulic machine which can be used either as a pump or as a motor and which is of the type wherein radial cylinders rotate around a stationary valve having a diaphragm dividing its induction and eduction ports and pistons within the cylinders derive reciprocating movement from an eccentrically situated ring this ring being adjustable in position to produce variable stroke and reversal In apparatus of this kind previously proposed the pistons have been definitely connected to the eccentric ring but the present improvements consist of a particular construction of such apparatus wherein the pistons are not in any way connected with the ring from which they derive reciprocating motion or to which rotary motion is imparted by them

As a consequence of this detachment of the piston heads from the eccentric ring with which they are associated it is necessary to provide means for maintaining the piston heads in working relation with the eccentric ring and another important feature of the device consists of an annular ring or annular rings by which this is effected

Fig 1 is a sectional elevation of a form of the apparatus specially designed for use as a pump

Fig 2 is a similar view of a modified form of the apparatus specially designed for use as a motor

Fig 3 is an elevational view partly in section of Fig 1

Fig 4 is a sectional elevation of the slipper employed

Referring to Fig 1 A designates the induction pipe and B the eduction pipe of a construction of the apparatus designed primarily for use as a pump

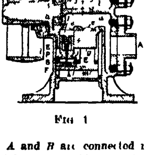

FIG 1

These pipes A and B are connected respectively to the low and high pressure sides a and b of a central cylindrical stationary valve c the high pressure side b of which is divided from the low pressure side a by means of a longitudinal diaphragm d This cylindrical valve c has inlet and outlet ports e and f respectively cut in it, and a cylinder body g is mounted to rotate upon this valve so that the open ends of the cylinders h co operate with these ports as the cylinder body g rotates upon the stationary valve c The cylinders h are arranged in the cylinder body preferably in more than one row, and the cylinders of one row are staggered in position relative to the cylinders in the next row The cylinder body is connected up to a driving wheel or pulley i by means of which the cylinder body is, when the pump is in operation continuously driven. Pistons j work in the cylinders h and these pistons carry at their outer ends slippers k which are capable of rocking on the pivotal heads l of the pistons Surrounding these pistons and cylinders a ring or drum m is arranged, which is capable of having its axis moved by means of the rods n to various positions on either side of the main axis of the apparatus which is, of course, also the axis of the cylindrical valve c. The axes of the cylindrical valve c and the drum m are always either coincident or parallel In operation the cylinder body g is continuously rotated, ball bearings o preferably being provided to reduce friction. If the axes of the valve c and the drum m are coincident the slippers k merely rotate in contact with the inner periphery of the drum and no flow of liquid takes place If however the axis of the drum is moved so that it is situated eccentrically in relation to the valve the reciprocating movements will be imparted to the pistons j and this reciprocation will cause fluid to enter the valve and cylinders from the pipe A on the low pressure or suction side a of the diaphragm and be expelled through the pipe B on the high pressure side of the valve

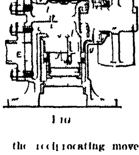

FIG 2

By this means a continuous flow of liquid is assured By altering the relative positions of the axes of the valve and drum m—that is to say by altering the degree of eccentricity between the valve and drum the length of the stroke of the pistons is altered and thus an effective variable stroke pump is provided If instead of utilizing the apparatus as a pump in the manner being described fluid under pressure is supplied through one or other of the passages a and b of the valve the apparatus will operate as a motor the reciprocation of the pistons j causing the slippers k to so operate in conjunction with the inner periphery of the drum so as to cause the bodily rotation of the cylinder body g and its attached wheel or pulley i and it follows that the speed of rotation of the wheel will be infinitely variable at will by varying the stroke of the pistons in the manner previously described

Where however a motor is required it is preferable to employ the particular design shown in Fig 2 which although operating in accordance with the same principles as the apparatus before described differs slightly in matters of construction

The differences in this construction are however confined to the provision of a floating liner or inner drum m' capable of rotation within the non rotatable drum m rollers r being interposed between two drums In addition to this the slippers k carried by the piston heads in the construction shown in Fig 1 are replaced in this instance by rollers s The action of the apparatus is exactly similar to that of the form shown

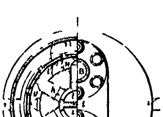

FIG 3

in Fig 1 That is to say fluid under pressure within one or other of the passages a or b of the stationary valve c will cause the reciprocation of the pistons j and the rollers s operating against the inner periphery of the floating drum or liner m' cause the bodily rotation of the cylinder body g and its attached driving wheel. In order to insure the piston heads, carrying either the slippers k or the rollers s always being held up to their work a ring I is provided in connection with each machine in which ring the heads of the pistons engage this ring always maintaining position concentric with the eccentric ring or drum m By this means the pistons are always maintained in proper working relation to the ring or drum or in the construction shown in Fig 2 to the inner floating liner m' of the ring or drum

In order to provide against any tendency of the slippers k to adhere to or frictionally grip the ring when pressure is applied a forced lubrication or pressure balancing device shown in Fig 4 is employed

In this case the piston proper j has a small piston l within it a spring s serving to keep the small piston out until the pressure rises sufficiently to overcome the pressure of the spring The pistons proper are bored right through and the passages thus formed run into passages F leading to the surface of the slipper I It will thus be seen that as the pressure rises oil is forced out of the passages I and the pressure fluid seeks to lift the slipper from the drum and as a consequence the slipper floats off on a film of oil when oil is the fluid with which the casing is filled Immediately the pressure on the small piston is so much reduced that the spring can operate to move such movement will cause the piston to be again replenished with oil or other fluid from the outside casing through the passage G fitted with a non return valve The Practical Engineer

IGNITION VELOCITY AND EFFICIENCY OF EXPLOSION MOTORS

In explosion motors the velocity of ignition is always much smaller than the theoretical value and

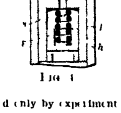

FIG 4

can be determined only by experiment It depends on the quantity composition and igniting point of the gaseous mixtures the amount and temperature of compression the position of the igniter its temperature and the quantity of heat furnished by it and the speed of the piston The velocity of ignition increases with the volatility of the combustible and the approximation of the proportion of the mixture to those of instantaneous ignition or explosion Witz finds that the velocity of combustion and the efficiency increase with the speed of the piston Compression is very advantageous up to 12 atmospheres beyond which point there is danger of spontaneous ignition

A collapsible steel dam has says the Engineering Record been in use for some time in Bear River Canyon near Garland Utah about thirty five miles above the point where this stream empties into Great Salt Lake It is essentially a steel crest built upon an existing crib dam of the Utah Sugar Company which may be lowered to reduce the water level on the upstream side and enable driftwood and floating matter that might injure the structure to be carried off In order to place the steel dam in position it was necessary to cut down the old dam [illegible] feet so that when the steel portion had been built its crest was at the same heights as that of the original dam The steel addition is hinged to the main structure in such a way that it may be folded into a longitudinal pocket or slot reducing the height about 4 feet and eliminating the danger of water cutting around the ends of the structure during floods and washing out the canals and headgates.

IS ETERNAL LIFE POSSIBLE ON THE EARTH?

THE VITALITY OF SEEDS.

Every one has heard of the grains of wheat which have been found in Egyptian sarcophagi and which when sown have sprouted and grown like ordinary wheat proving that they had retained their vitality for thousands of years In Pompeii also has been found wheat which is alleged to have preserved its power of germination We are told that plants of various sorts have been raised from seed found in Gallo Roman graves and in Peruvian graves dating back at least [illegible]00 years before the Inca dynasty

Many treatises on botany and forestry contain the assertion that after extensive tracts of timber have been cleared many species of plants formerly unknown in the forest often appear The inference is that these plants spring from seeds which have lain dormant in the ground for centuries awaiting conditions favorable to their germination and growth Another familiar story is that of the microscopic animal organisms known as infusoria and rotifera or wheel animalcules which when dried retain their vitality for indefinite periods and immediately become active when they are placed in water Assertions of this character which formerly met with universal acceptance led Claude Bernard to his conception of latent life Bernard distinguished three principal forms of life manifest retarded and latent In manifest life respiration metabolism and other physiological processes go on briskly The chief characteristic of manifest life is the formation of new tissue or at least the continual renewal of cells which are the elements of tissue In retarded life the physiological processes are performed less energetically and the organism prolongs its existence only by consuming nutriment which it has previously stored up There is no formation of new tissue no substitution of new cells for those which have died but some elements of the body are kept alive by the destruction of other elements The hibernation of certain animals and the winter life of bulbous and tuberous plants are examples of retarded life In latent life all physiological activity is arrested there is no exchange of matter between the organism and the external world by respiration transpiration or otherwise and inside the body there is no construction destruction or alteration of cells Examples of latent life are furnished according to Bernard by the seeds spores and eggs of plants and animals and by the desiccated infusoria and rotifera mentioned above

According to Gaston Bonnier in Kosmos when we examine attentively the stories of the germination of seeds found in medieval Gallo Roman and Celtic graves we find that the plants alleged to have sprung from those seeds were usually such very common weeds as mercury bindweed cornflower and camomile which would very likely have appeared even if no seeds had been sown as no precaution seems to have been taken to prevent the access of weed seeds These haphazard experiments resemble those which are brought forward as evidence of transmutation of species Seed of one species is sown plants of a different species appear and it is inferred that one species has been transformed into the other For example if I sow some wheat not knowing that it has lost its power of germination and poppies spring up I must according to this method of research conclude that wheat has been changed into poppies

This idea of the longevity of seeds is so firmly rooted in the minds of a majority of educated persons that the most absurd errors have been committed Prof Heldreich of Athens saw the yellow horn poppy (*Glaucium flavum*) growing on ground from which a thick layer of mine refuse had lately been removed As the scoria came from an ancient Greek mine and had been thrown on the site 1[illegible]00 years previously the botanist concluded that the seeds of the horn poppy had lain buried for that length of time This plant is especially prolific of astonishing phenomena An English botanist is said to have found horn poppies growing in the débris of rocks of the secondary formation which had been covered by a lias deposit and to have inferred that the plants sprang from fossil seeds which had retained their vitality from that remote geological period This reminds me of an article which appeared in the Paris Figaro at the time when the foundations of the basilica on Montmartre were laid The journalist a man of scientific education having seen many plants growing from the sides of the deep excavations which were dug in the gypsum rock in the preceding year assumed that these plants sprang from seeds deposited with the gypsum in the eocene or beginning of the tertiary period millions of years ago I showed this article to many well-educated persons but not one of them either expressed great astonishment or suggested that the seeds might have been brought by the wind [illegible] you tell a man that you have been bitten by a fox [illegible] he will think you demented but if you tell him that you sowed fossil seeds and they grew he recalls the famous mummy wheat and deems the occurrence remarkable but not improbable

Now let us turn to statements which have basis of fact Seeds of the sensitive plant (*Mimosa sensitiva*) have germinated after having been kept sixty years Much has been made of the single bean gathered by Tournefort which is said to have sprouted after it had lain a hundred years in the herbarium but other beans from the same pod failed to sprout when tested by another experimenter A century is very short in comparison with the age of eocene deposits or even that of Egyptian mummies If the life of seeds is entirely latent and they are protected from external influences by being kept in closed vessels they should infallibly retain their power of growth but gardeners and seedsmen know that this is not the case

In 1846 Alphonse de Candolle sowed in the most favorable conditions for germination many seeds of 368 species which had been kept fifteen years Of 351 species not a single seed germinated and in most of the remaining 17 species the number of seeds that sprouted out of [illegible]0 sown varied from 1 to 3

Similar results have been obtained from experiments with the microscopic animal forms infusoria and rotifera In 190[illegible] Richters described his experiments with rotifers which he found in Spitzbergen moss in vast numbers 30 animalcules in each grain or 13 000 in each ounce of the dried moss Experiments with one species (*Macrobiotus oromifer*) yielded the following results Kept dry for 9 months they returned to manifest life after [illegible] minutes soaking and shaking After [illegible] months of desiccation [illegible] minutes immersion in water was required to restore their activity After [illegible] months some but not all of the animalcules were revived by an immersion extending over more than an hour and after [illegible]0 months of desiccation none could be brought back to manifest life These experiments prove clearly that the life of the animalcules in the dry state is not the latent life of Bernard's classification but is marked by very slow physiological and chemical changes which ultimately make return to manifest or active life impossible

In conjunction with Van Tieghem I have made some experiments for the purpose of determining whether or not any perceptible exchange of gases occurs between seeds and their environment We found that dry seeds absorbed very small but measurable quantities of oxygen and exhaled very small but measurable quantities of carbon dioxide In other words the seeds breathed though very feebly We also detected a very slight exhalation of water vapor

Hence we concluded that respiration continues in organisms which are commonly regarded as being in the condition of latent life and that the organisms die when respiration ceases The life of such organisms therefore is not strictly latent but only dormant or retarded Our results have been contested by adherents of the theory of absolutely latent life Casimir de Candolle asserts without supporting the assertion by experimental evidence that the slight respiration which we detected can occur only in fresh seeds which have not yet passed from the condition of retarded life into that of absolutely latent life Yet some of our seeds were several years old

Kolkwitz has recently obtained results identical with ours He finds that perfectly dry barley absorbs oxygen and exhales carbon dioxide The respiration is increased by crushing the grains and is not arrested by grinding them and steeping them for several hours in boiling water or 90 per cent alcohol Paul Becquerel has repeated these experiments with a great variety of dry seeds and has confirmed the regular occurrence of respiration and transpiration as long as life remains—even in some exceptional seeds which still retained the power of germination although they were eighty years old

Let us return to the seeds found in the graves of the Pharaohs The only striking peculiarity in the external appearance of such seeds is their color which is generally reddish brown. According to analyses made by Bonastre in 1828 the so-called albumen ' stored in the seed close to the embryo which it supplies with the nutriment required for germination, contains several organic substances which remain unaltered for ages The starch of these seeds was colored blue by iodine like freshly formed starch This is a remarkable discovery which proves that some organic compounds may be preserved indefinitely, in appropriate conditions but it does not prove that the seeds which contain these compounds will germinate. For germination at least three conditions which have recently been formulated by Prof Gain, of the university of Nancy must be satisfied 1 The food reserves must be chemically unaltered. 2. The embryo must still be able to secrete the liquid by which the food is digested 3 The embryo must remain in contact with the food supply The first condition is satisfied in much of the grain found in Egyptian graves but the other conditions are not satisfied Gain has discovered by microscopic examination of sections that the embryos of these grains are usually shrunken and disintegrated and that their individual cells fail to show the reactions characteristic of the cells of living embryos Hence the embryo is both detached from the food reserve and unable to produce digestive juices

Gain arrives at the following conclusion The seeds found in Egyptian graves though apparently well preserved no longer possess the cellular structure required for germination The food reserve often shows little chemical alteration but the embryo has undergone extensive chemical changes which prove that even the retarded life of the seed has long been extinguished Gain has classified seeds according to age from the appearance of thin sections under the microscope thus following the successive stages of the internal changes wrought by time in the apparently unaltered seeds

Still more recently Gain and Brocq Rousseau have studied both the germinating power and the digestive diastases of seeds of various ages ranging from 2 to 3 000 years The seeds were obtained from 12 botanical and archæological collections and included seeds from ancient Peruvian tombs In general the diastases were preserved longer than the germinating power but in no instance longer than 200 years while no seed more than 100 years old could be induced to germinate Yet men of scientific education are alleged to have actually observed the germination of wheat found in the tombs of the Pharaohs

The distinguished Egyptologist Maspero in a letter written to Prof Griffon explains this discrepancy as follows

A distinction must be made between experiments with seeds purchased from natives and purporting to come from ancient tombs and experiments with seeds which have been found in the tombs by the experimenters or have been obtained from trustworthy persons In the former case the seed almost always germinates in the latter case it never does so to my knowledge The inference is obvious The fellahs adulterate the ancient seed which they sell with at least an equal quantity of new seed, the latter germinates and the former does not I have found in tombs many seeds of wheat barley hemp flax and other plants Some of the seeds had been parched others had been steeped in lime water but many had been deposited in the tombs without any apparent preparation Not a single seed of any of the three classes has germinated

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The question of finding terrestrial position is usually associated with a measurement of altitude which has either to be taken from the sea level datum, if the sea horizon is visible or from an artificial horizon when the natural horizon is invisible In many cases, however neither of these methods are available and it is desirable to devise some such procedure as would enable the occupants of a balloon, say to determine their position with sufficient accuracy to warrant their descent on any pre-defined district whose topographical features may not be recognizable If the error of observation is about half a degree the resulting position would be out by some thirty miles Mr C V Boys has devised an instrument to do this of the type of swinging collimator and sextant combined The collimator is vertical and is suspended on a gimbal frame, the whole being top-weighted like a metronome, so as to have a period of swing of about one second The collimator is provided with a fine scale adjusted at its focal plane, above the lens is fixed a clear or half silvered glass mirror set at 45 deg with the axis of the collimator The whole is then suspended in a tube forming the handle of the instrument to which is attached the ordinary parts of a small sextant When looking in the telescope the star will be seen projected upon the scale, one half of which is marked +, the other — and by having the instrument calibrated, these readings may be made to indicate altitudes direct. Without the top controlling weight it is found impossible to hold the instrument steady enough but when the period is increased to about one second by top-weighting, the angular movement is so reduced that by sitting at a table an accuracy of one minute of arc is possible.—Knowledge

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Letters can now be automatically registered in Berlin by an automatic penny-in-the-slot machine placed in the post offices, which specially stamps the letters and saves the sender from waiting.

INDUSTRIAL FELLOWSHIP IN UNIVERSITY WORK.

CO-OPERATION BETWEEN UNIVERSITIES AND MANUFACTURERS.

BY CHARLES MOREAU HARGER.

No development of industrial effort is more interesting than that connected with the search for better methods of doing things The constant attempt of the great corporations to secure new ideas and to improve old ones is leading them into new fields That they should reach into the curriculum of the college and university is but the natural outcome of the scientific side of business life The student with time and materials at his disposal is especially fitted for searching into hidden fields and it is a curious fact that the most definite effort is being made in one of the western schools, the University of Kansas where eleven fellowships have been established for the study of special subjects These are all in the department of industrial chemistry under Prof Robert Kennedy Duncan

Prof Duncan three years ago called the attention of manufacturers to the need of greater efficiency in their methods and suggested that they should keep abreast with the times in making special provision for securing larger results In magazine articles and books he pointed out the revolution of industrial chemistry and explained the opportunity that lies in many directions awaiting the effort of students Out of this came the establishment of these eleven fellowships which are in operation except three recently offered

1 An investigation into the chemistry of laundering with the object of saving laundered fabrics $500 a year with ten per cent of the profits

2 A search for a new diastase with an attempt to make a new fodder on scientific principles $500 a year and ten per cent of gross profits for three years

3 Utilization of the constituents of waste butter milk primarily caseine and secondarily lactic acid and milk sugar, $500 a year and ten per cent of the net profits

4 An investigation into the chemistry of baking established by the National Master Bakers Association with the object not only of improving the chemistry of bread but as well of providing for the association of a trained expert on whom they could thereafter rely $500 a year together with a sum to be settled by arbitration

5 An investigation into the constituents of crude petroleum, $1 000 a year and ten per cent of the net profits

7 An investigation into the relation between the optical properties of glass and its chemical constitution, $1 500 a year and ten per cent of the profits

8 The discovery of new uses for Portland cement and of improvement in its manufacture, $1 500 a year and a large additional consideration dependent upon success

9 An investigation into certain glands of deep sea mammals $1 500 a year and an additional consideration to be determined by arbitration

10 The discovery of new utilities for ozone, $2 000 a year and 10 per cent of the net profits

11 An investigation into the various methods of chemical treatment of woods to find results of commercial and scientific value, $1 500 a year

Eight of these fellowships are being worked out the other three Nos 9 10, and 11 have either not been filled by appointment or not fully established though all are assured This is the contract (No 7) under which they are undertaken

MEMORANDUM OF AGREEMENT

"For the purpose of promoting the increase of useful knowledge the University of Kansas accepts from the A B C Glass Company, having head offices at New York, the foundation of a temporary industrial scholarship to be known as the A. B C Fellowship

"It is mutually understood and agreed that the conditions governing this fellowship shall be as follows

"The exclusive purpose thereof is an investigation into the optical properties of glass in relation to its chemical constitution to the furtherance of which the holder shall give his whole time and attention with the exception of three hours a week, which he shall give to work of instructions in the chemical department.

"The fellow shall be appointed by the Chancellor of the University, the Director of the Chemical Department, and the Professor of Industrial Chemistry, he shall have made previously a reputation in research; he shall be a member of the university, and shall pay all regular fees with the exception of fees for laboratory and supplies, for which the instruction given by him shall be taken in lieu, unless in the opinion of the appointers his demands become excessive, in which case the donor shall reimburse the university. he shall work under the direction and advice of the Professor of Industrial Chemistry and he shall forward periodically through the Professor of Industrial Chemistry reports of the progress of his work to the A B C Glass Company

For the support of this fellowship which shall extend through a period of two years from the date of appointment of the fellow the A B C Glass Company agrees to pay $1 00 per year payable annually to the university on the date on which the fellow begins work at the university This sum shall be paid by the university in montuly instalments to the holder of the fellowship

Any and all discoveries made by the fellow during the tenure of this fellowship shall become the property of the A B C Glass Company subject however to the payment by them to the fellow of ten (10) per cent of the net profits to be commuted at the desire of either party through the arbitration provided for herein arising from such discoveries it being understood that the fellow shall be regarded as the inventor At any time during the tenure of his fellowship the holder shall at the option of the donor take out patents at the expense of the donor on condition that at the time of making application therefor he shall assign his right to the donor under the conditions of this agreement At or before the expiration of the fellowship the business services of the fellow may be secured by the A B C Glass Company for a term of three years on condition that the terms of such services are satisfactory to both parties at interes

In the event of any disagreement between the donor and holder of this fellowship it is understood and agreed that the Chancellor of the university or one whom he may appoint shall act as arbiter as to all matters of fact that his decisions shall be binding upon the parties at issue and that they shall obtain such decision before having recourse to the courts

It is also understood and agreed that during the tenure of this fellowship the holder may publish such results of his investigation as do not in the opinion of the company injure its interests and that on the expiration of the fellowship the holder thereof shall have completed a comprehensive monograph on the subject of his research containing both what he and others have been able to discover A copy of the monograph shall be sent to the A B C Glass Company and a copy shall be signed and placed in the archives of the university until the expiration of three years from that date when the university shall be at liberty to publish it for use and benefit of the people

Signed on behalf of the University of Kansas

Date

Signed on behalf of the A B C Glass Company

Date

Some of the advantages accruing from these fellowships says Prof Duncan is that the university gains increased opportunities of promoting research it obtains three hours a week of gratuitous instruction from men of ability knowledge and enthusiasm the Chemical Department in particular obtains the catalytic influence of these men The manufacturer obtains the advantages of enormously increased laboratory facilities adequate library facilities a most important advantage the lack of which had seriously hampered much factory research consultative advantages for the fellow appointed was at liberty to question specialists in the different fields of chemistry or in other fields of scientific knowledge complete freedom from supervisional responsibility over the work and on the termination of the fellowship the services of a man educated to his particular needs The fellow obtains all the foregoing advantage ascribed to the manufacturer and in addition the all important sympathetic co operation of the manufacturer together with inside knowledge of the factory processes and the university s environment sympathetic to research also a freedom from all petty interferences and jealousies of shop people and the pot shot judgments of factory officials Finally if he prove worthy of it he obtains a position for which he had become through his training peculiarly qualified

'Since at the end of three years all work done under any fellowship must be published free to the public the public thus obtains new implements of civilization. It is only through the industries that any useful discovery goes to the people The insertion of this clause had been occasionally resisted for a time but the donor had always in the end acquiesced when it was pointed out that a really progressive manufacturer would find three years a sufficient start

Since this whole scheme depended upon sympathetic co operation it could only be carried out through a professor who regarded it as a sacred trust It was therefore positively necessary that the Professor of Industrial Chemistry should so far as any material sense was concerned gain absolutely nothing otherwise his donors would not trust him with the details of their secret processes nor would his fellows trust him with their progress

The problem of meeting the demands of education in the highest sense and at the same time fulfilling the requirements of the industrial world is one that has been made a study by educators for many years and it is believed that this is the most capable solution that has been reached in this country The activity of the department has been supplemented by the manufacturers money and it found that the students accomplish much that is worth while They spend their time enthusiastically and though none of the undertakings have been completed the outlook is favorable for securing very practical results The equipment needed for the investigations has been furnished partly by the regular facilities of the university and partly out of the added appropriations for this work and it is complete and scientific in every particular The interest manifested by the students who show the greatest of pleasure in giving this their attention is of especial note and indicates that there is among the young men of the universities and colleges a willingness to enter upon such work That it may be developed to yet greater extent is apparent and that it has attracted more than local attention is seen from the wide scope of the fellowships offered coming as they do from the large cities of the East as well as from the West

The importance of this kind of university work is appreciated by the manufacturers who not only make many inquiries concerning the progress of the work in general but are eager to give all assistance in their power Many different lines have been proposed that have not yet found the donor of a fellowship fund but which will in the end materialize The students who are working on the various lines are recognized in the world of commerce The fellow who is studying bread making has been invited to make addresses before the master bakers associations in several States this season and his addresses on the chemical processes involved in breadmaking have been received with appreciation

That the university can do a great deal for commerce is being recognized and the start that has been made in this instance is not only unique but has the merit of being of direct use to the business world Prof Duncan says one of the most serious problems connected with it is to so adjust the income from discoveries that while they may be useful do not actually increase the income of the fellow This has been the subject of many consultations and will have to be solved before the system enters on its fullest success when carried on generally However the donors have been willing and anxious in every particular to make the arrangement mutually advantageous because it is realized that only by that method can the best results be obtained The English Society of Chemical Industry devoted one of its sessions last summer to the subject and Prof Duncan was the principal speaker His plan received the endorsement of his confreres and was taken as a worthy development of plans that have been followed in Europe for similar accomplishment

Commenting on a recent discussion by the New York Railway Club on surprise and efficiency tests a contemporary remarks that even the best of automatic signals cannot prevent collisions It is necessary to take account of the train crew as is well shown by the statistics published by the Interstate Commerce Commission In these it was seen that out of the 152 preventable collisions and derailments during two years 21 cases were due to negligence on the part of drivers to observe signals It must be conceded therefore continues our contemporary that the best of signal systems maintained by a good staff of properly paid men must be supplemented by something which will teach the drivers the importance of observing all rules and signals Up to the present there has been nothing devised so good as surprise tests by which the manner in which signals and rules are obeyed is actually examined and recorded It is a troublesome and exasperating thing to do but so is the surprise fire drill required once a week on all passenger steamships

NUMBER OF TILES FOR A GIVEN AREA

The building contractor who at times includes in his operations the setting of the tile will find the accompanying table reproduced from the Mantel Tile and Grate Monthly of great convenience in arriving at the number of tiles of given dimensions and shape required for a given area After computing the area of the surface to be tiled and having learned from the owner or architect just what size and shape of tiles are desired it is an easy matter to arrive at the number required by multiplying the area in square feet by the number of tiles given in the table for each square foot of surface

No	Shape	Size in Inches	Number in Square Foot
1	Square	6 x 6	4
2	Diagonal ½	6 x 6	8
3	Square	4¼ x 4¼	8
4	Diagonal ½	4¼ x 4¼	16
5	Square	3 x 3	16
6	Diagonal ½	3 x 3	32
7	Square	2¼ x 2¼	[illegible]
8	Diagonal ½	2¼ x 2¼	64
9	Square	1½ x 1½	64
10	Diagonal ½	1½ x 1½	128
11	Square	1 1/16 x 1 1/16	128
12	Diagonal ½	1 1/16 x 1 1/16	256
15	Square	2 x 2	36
16	Square	1 x 1	144
17	Oblong	6 x 4	6
18	Oblong	6 x 3	8
19	Oblong	6 x 2	12
20	Oblong	6 x 1½	16
21	Oblong	6 x 1	24
22	Oblong	4¼ x 2⅛	16
24	Oblong	4¼ x 1 1/16	32
25	Oblong	3 x 1½	32
26	Oblong	3 x 1	48
27	Oblong	2⅛ x 1 1/16	64
28	Octagon	6 x 6	4 4/7
29	Octagon Diagonal ½	6 x 6	9 1/7
30	Octagon Square ½	6 x 6	9 1/7
31	Octagon Square ¼	6 x 6	18 2/7
32	Hexagon	6 x 3	10 2/3
33	Hexagon Long ½	6 x 3	21 1/3
34	Hexagon Short ½	6 x 3	21 1/3
[illegible]	Octagon	3 x 3	18 2/7
42	Hexagon	6 x 5 3/16	6 1/6
43	Hexagon Diagonal ½	6 x 5 3/16	12 1/3
44	Hexagon Square ½	6 x 5 3/16	12 1/3
48	Pentagon	5 1/16 x 2¼	14 2/9
49	Octagon	4¼ x 4¼	9 1/7
50	Octagon Diagonal ½	4¼ x 4¼	18 2/7
51	Octagon Square ½	4¼ x 4¼	18 2/7
52	Oblong	3 x ½	96
54	Oblong	6 x ½	48
55	Hexagon	4¼ x 2⅛	21 1/3
56	Hexagon Short ½	4¼ x 2⅛	42 2/3
57	Hexagon Long ½	4¼ x 2⅛	42 2/3
58	Square	½ x ½	576
59	Oblong	6 x ¾	32
60	Hexagon	3 x 3 11/32	18 2/7
61	Hexagon Diagonal ½	3 x 3 11/32	36 4/7
62	Hexagon Square ½	3 x 3 11/32	36 4/7
63	Oblong	3 x ¼	192
64	Hexagon	2 x 2 5/16	41½
65	Hexagon Diagonal ½	2 x 2 5/16	83
66	Hexagon Square ½	2 x 2 5/16	83
70	Oblong	9 x 3	5 1/3
71	Oblong	6 x 4½	5 11/17
72	Oblong	1 1/16 x 17/32	256
77	Oblong	5 x 10	2 22/25
81	Hexagon	2 5/16 x 2 21/32	31 2/10
82	Hexagon Diagonal ½	2 5/16 x 2 21/32	62 3/5
83	Hexagon Square ½	2 5/16 x 2 21/32	62 3/5
84	Hexagon	1⅞ x 2	54¼
85	Hexagon Diagonal ½	1⅞ x 2	108½
86	Hexagon Square ½	1⅞ x 2	108½
87	Triangle	3	37
88	Half Triangle	3	74
89	Triangle	1 47/64	109 5/7
90	Half Triangle	1 47/64	219 3/7
91	Triangle	1 5/32	249
92	Half Triangle	1 5/32	298

In regard to the above it may be stated that a small number of tile should be added ordinarily to cover breakage and losses

From a study of the concentric annual layers of growth of conifers growing in various latitudes between the 60th and 67th parallels Lemstroem finds that the thickness of the annual layer varies according to a definite law showing maxima and minima which indicate a period of ten or eleven years coinciding with the period of sun spots and auroras The differences furthermore are greater in the great firs within the Arctic circle at 67 deg north latitude than in trees growing further south This is quoted as tending to indicate that the atmospheric electricity of the polar regions exerts a beneficial effect upon vegetation

ENGINEERING NOTES.

A paper read on waterproofing by Mr Myron H Lewis before the Municipal Engineers of New York is now issued in pamphlet form The author limits attention to those branches of work defined by him as waterproofing engineering which relate particularly to means of protecting structures against injury by water and the occupants of structures from discomfort due to the penetration of water He considers not only methods of treating various substructural conditions but also the treatment of concrete so as to make it impermeable He discusses the treatment of the materials and that of the structures in which they are employed before and after erection above or below ground and in water Mr Lewis is quite right in saying that defective waterproofing is almost worse than none He is an advocate of the axiom that the best is the cheapest and in addition to theoretical consideration he goes thoroughly into practical details in a manner which we are sure will be appreciated by our readers The value of the paper is enhanced by various specifications for waterproofing work including those adopted for the New York rapid transit subway the Long Island Railroad tunnel and concrete bridges on the Chicago and Northwestern Railway

The following formulas for estimating the approximate weights of bridges of different types (up to 550 feet spans) have been obtained from actual construction and if there is any criticism to find in them it is that they are too close an approximation The term Hot Metal Bridge applies to a structure having a solid buckle plate floor system and sides sufficient to provide protection for river and other travel underneath same during the transit of hot metal from furnaces to the mills (1) Ordinary pin connected through truss open floor system single track $W = 7.5 L^2 + 700 L$ (2) Do Double track $W = 12 L^2 + 1\,000 L$ (3) Double track through truss pin connected solid floor system of furnace sand hot metal bridge $W = 16 L^2 + 2\,800 L$ (4) Ordinary deck plate girders single track open floor $W = 10 L^2 + 300 L$ (5) Do Hot metal $W = 12 L^2 + 1\,000 L$ Where W = total weight of steel work in pounds and L = extreme length in feet Based on a live load similar to Cooper's class E 50 but with particularly heavy loads on cars suitable for hauling metal around Pittsburg Proceedings of the Engineers Society of Western Pennsylvania

In addition to the Eades viaduct of which some particulars were given by us French engineers are to be credited with the boldly designed steel bridge for the new railway from Piraeus to the Turkish frontier This structure is about 700 feet long and spans a ravine some 600 feet from side to side and more than 325 feet deep at the lowest point Emerging from a tunnel at either side railway trains will traverse either one or four girder spans according to direction and then pass over an arch of 262 feet span with the rise of 78 feet this arch being of the three hinged type The five girder spans each 85 feet long are supported on lofty masonry piers The whole of the steel work was prepared in the yard of the contracting firm in Paris and transported thence by rail Considering the exceptional facilities possessed by some of our Northeast coast and Scottish firms for the economical production and shipment of structural steel work it seems a little strange that an inland French company should be able to secure the work Of course there may be special reasons for this but in any event it is well that British industrial concerns should recognize the enterprise and marked ability of their friendly rivals in France

A quantity of water which is rich in iron is now being used for town supplies in Germany and in these cases the process of preliminary aeration is resorted to in order to remove the bulk of the dissolved iron salts It is maintained by Mr Oesten of Berlin that such water is liable to reabsorb iron from the mains and the subject has been vigorously debated Dr Noll supposes that the reaction which takes place may be explained by the following equation As soon as the protective coating on the surface of the iron is worn away and the metal is exposed we have $Fe + CO_2 + H_2O = FeCO_3 + H_2$ and if free oxygen is present in the water a separation of iron hydroxide takes place causing a deposit in the mains In this case the carbonic acid is liberated and further iron is dissolved or the mono-carbonate of iron may be converted into bicarbonate If the water contains an abundance of oxygen and but little carbonic acid gas a re-combination of carbonate of iron with the water cannot occur, but the amount of hydroxide of iron formed in the mains is larger If but little oxygen and abundant carbonic acid are present a large amount of bicarbonate of iron will be formed It is pointed out that in the Hamburg waterworks since the substitution of filtered Elbe water for the untreated river water both the cast and wrought iron mains have been strongly attacked, and Dr Noll suggests that when river water was in use the organic matters present tended to form a protective slimy coating on the pipes, which prevented the aggressive action of the carbonic acid The theory of the reaction put forward by Dr Noll is stated however, by Mr Oesten to be inapplicable in the case of the Berlin mains—Times (London) Engineering Supplement

TRADE NOTES AND FORMULÆ.

Quick-drying Paint.—10 parts yellow wax, 10 parts linseed oil 5 parts dammar or rosin 8 parts of turpentine

Alloys Casting Delicate Shapes

Bismuth	6	5	2	8
Tin	3	2	1	3
Lead	13	3	1	5

Alloy for Marking Gage for Printers.—1 Copper 100 zinc 13, tin 10 2 Copper 17, zinc, 2, tin, 1 First melt the copper throw in the zinc, wrapped in paper then the tin and stir with a stick until the alloy is of uniform consistency

To matt aluminium immerse the object in strong soda lye until gas bubbles form copiously on its surface rinse it lay it in strong nitric acid and rinse it again The object will by this means be given the appearance of matt or frosted silver

Embalming Fluid for Animals, Corpses, etc—Make a solution of 80 parts of potash 60 parts common salt 30 parts saltpeter and 160 parts of alum in 6 000 parts of water heated about 120 deg F add to this a second solution of 18 parts of salicylic acid in 600 parts of methylated alcohol To the mixture add 60 parts of carbolic acid and 1 800 parts of glycerine

Luminous Paint Mix 100 parts of carbonate and phosphate of lime (obtained by heating or calcining shells) with 100 parts burned lime then add 25 parts of calcined sea salt and 2 to 50 per cent of the entire quantity (i e 66 to 112 parts) of sulphur finally admix 6 to 7 per cent of a luminous substance made from a combination of sulphur with barium calcium strontium magnesium or aluminium) added and mixed with varnish

To Color Powders with Aniline Colors—Add hydrochloric acid to a dilute solution of water glass as long as any precipitate of silica is thrown down transfer the later to a filter and wash as long as it continues to absorb soluble matter A solution of an anilin color is then poured over the precipitate the coloring substance will be almost completely retained by the silica acid after the precipitate has been dried we have a colored powder which can be ground up with dissolved glue or gum for use in printing wall papers etc

Aluminium Solder (according to M H Laucon)—Melted aluminium is covered with a layer of phosphoric acid acid sodium sulphate or other acid salts and then the metals serving as solder added Aluminium Solder for Wire and Their Objects 9 parts aluminium 1 part copper 4 parts tin 95 parts aluminium 1 part copper 2 parts bismuth 1 part zinc 1 part tin solder for larger objects 95 parts aluminium 2 parts copper 2 parts antimony 1 part bismuth 1 part zinc 60 parts aluminium 13 parts copper 15 parts antimony 10 parts bismuth 2 parts tin

Colored alcohol flames for stage purposes funerals etc Dissolve according to the intensity of color the flame is to display in a mixture of 90 per cent alcohol and petroleum 5, for white chloride of zinc or chloride of magnesium, yellow nitrate of ammonia Chile saltpeter or common salt pink and orange chloride of calcium chloride of lithium separate or mixed possibly with the addition of chloride of strontium and dissolved in the strongest alcohol red chloride of strontium pale green borack acid dark green chloride of copper violet, chloride of copper poured on to cotton wool soaked with ammonia, by the addition of chloride of strontium chloride of calcium or chloride of lithium, the shading of the violet flame may be effected dark blue mountain blue or blue carbonate of copper kneaded into tow, soaked in alcohol and some ammonia poured over it faded pale blue, 90 per cent alcohol with no addition The solutions are either allowed to burn by themselves in earthenware saucers or bunches of dry tow are placed in them to serve as wicks

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GREAT BRIDGE OVER THE RED RIVER IN INDO-CHINA

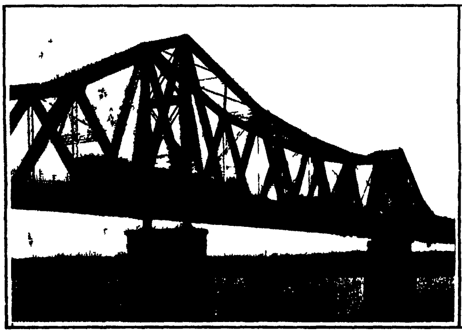
An enterprise of considerable scope in the French provinces of the Extreme Orient is the new railroad line known as the Yunnan system. The already existing railroad in the region of Tonkin in Indo-China will be further extended by an addition which is somewhat more than its present length, and is to run across the frontier and through Chinese territory. The two branches of railroad constitute a continuous line somewhat over 500 miles in length. At present the Haiphong-Hanoi-Laokai railroad extends from the coast through the important center of Hanoi and thence to the Chinese frontier, continuing from this point by the new section of line which is now in construction. One of the most important features of the new road is the great bridge erected across the Red River, which has a total length between abutments of 5,544 feet, and thus ranks as one of the longest railroad bridges in the Old World. The Red River, even at the seasons of low water, is of a considerable width, and during the high-water periods this width is very much increased, hence the need for the above unusual length. By reason of the freshets which occur in this river and are quite noteworthy, special precautions were required in bridge building at this point. The work could only be carried out during the period extending from October to May, and work had to be stopped entirely during the rest of the year owing to the freshets which cover this period.

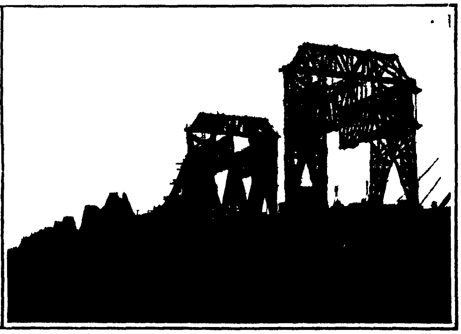
The present construction is known as the Doumer Bridge, being so called from the former Governor General of Indo-China. It is of the cantilever type, this being found to be the best adapted for the prevailing conditions in the Red River. The contract for the work was given to the Daydé and Pillé firm.

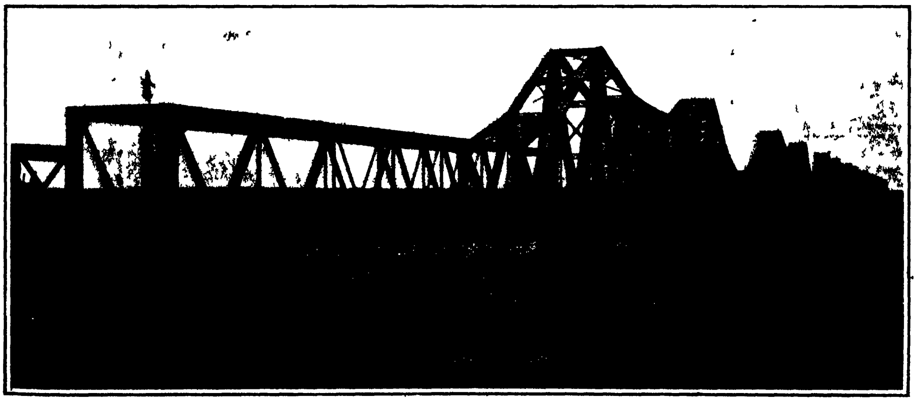
The bridge contains 19 spans. It consists of a series of cantilevers supporting parallel trusses 248 feet in length. The alternate spans measured between centers of piers are respectively 350 and 429 feet in length. The depth of the cantilevers above the piers is 56 feet, at the point of junction with the suspended trusses the height decreases 20 feet.

The main platform of the bridge is used for the railroad track, and at each side there is a 4-foot [illegible] inch footway which is supported by a bracket construction lying outside of the main part of the bridge. The railroad rails are laid on longitudinal timbers and are provided with compensators so as to allow for expansion of the rails. There are ten such devices along the whole length of the bridge, and they are regulated for a range of 70 deg. C. As to the straight trusses, they have a length of 168 feet 4 inches, a uniform height of 20 feet, and a rectangular section. As to the width, the main beams of the bridge have 1[illegible] feet 10 inches between centers, leaving an inner space of 13 feet, while at the outside is the footway mentioned above. The total width of the bridge between outside railings is 26 feet [illegible] inches.

The bridge is carried on 18 piers, and they were built by the compressed air metallic caisson system, going down to a hard bearing at a depth of 108 feet 2 inches below low water level. At the base the piers have a rectangular area of 23 feet [illegible] inches by 14 feet [illegible] inches, terminating in a semicircular section at the ends. This section prevails in the pier for some dis


ONE OF THE CANTILEVERS


VIEW SHOWING THE ERECTING GANTRYS


THIS FINE STRUCTURE, BUILT BY FRENCH ENGINEERS, CONTAINS 19 SPANS AND HAS A TOTAL LENGTH OF 5,544 FEET

THE GREAT CANTILEVER RAILROAD BRIDGE OVER THE RED RIVER, INDO-CHINA tance above water level but it is diminished at a point near the bridge structure and at this point it has a rectangular section of somewhat smaller dimensions From bottom to top the height of the pier is very near 140 feet

The greatest rise in the river is [illegible] feet and its velocity [illegible] feet per second which occurs between June and November was as we have already mentioned an obstacle in the construction of the bridge Under these conditions the work had to be arranged so that it could be rapidly carried forward during the low water periods and entirely suspended for the rest of the year Another point is that during the high water periods a great number of timber rafts [illegible]00 feet in length pass down the river so that the piers must be protected from damage during this period in the intervals when work is being carried on During the working season from November to June the construction had to be therefore pushed as rapidly as possible and for this purpose there were employed between 2 000 and 3 000 native workmen who were directed by 40 engineers or foremen In the construction work of the piers by means of the caissons the working range extended for a length of over half a mile at a time An extensive plant had been erected on shore which included all the machine shops necessary for the work besides an electric plant so that the whole of the bridge work could be provided with electric light The caissons for the 18 piers and the two abutments were all sunk in two seasons from October to May in each case and this will give an idea of the rapidity of the work It is also to be remarked that all the native labor employed on the bridge was previously untrained

The method used in the mounting of the steel work of the bridge by means of scaffoldings will be remarked in our engravings one of which shows the bridge as it is nearing completion As this work had to be carried on rapidly during the available period of the year the construction firm made use of a movable scaffolding under the bridge which left a space of 80 feet in the river for navigation When one part of the construction was finished the scaffolding was advanced to the forward part of the work For the upper part of the work there were used the large erecting gantrys shown in the engravings In the present bridge the total weight of the steel work is [illegible] 700 tons and there was used in all 2 22[illegible] 000 cubic feet of masonry for the piers and abutments

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FRICTION CLUTCHES.*

THEIR PRINCIPLES OF DESIGN.

BY J. RICHARDS.

In a late letter from an eminent designing engineer in England there is the following remark I do not like friction clutches and never under any circumstances embody them in a design when their functions can be attained by other means This I conceive to be a common opinion among engineers and mechanics and considering the many very useful functions performed by these clutches it is certainly time to proceed to some analysis of the matter to find out wherein the faults lie

Beginning generally so to speak their purpose is to transmit power and motion by tractile force or friction as has been done for centuries by bands in a very satisfactory manner the conditions of operating being much the same or nearly the same the main distinction being that in stopping and starting the cumulative tractile force is in the case of bands attained by the extent of area in contact and in the case of clutches by the amount of pressure between the tractile surfaces This proposition being one of fact needs no discussion but out of this fact comes a corollary of much significance the key in fact to the impediments and bad reputation of friction clutches

In these of whatever kind the engagement and the tractile force exerted are both functions of pressure so also is their endurance but this latter will be considered further on

PRESSURE AND ENDURANCE

Pressure on the surfaces is also a commercial exponent of friction clutches Their dimensions and cost to construct are inversely as the pressure to be endured and in this fact lies the incentive to high and destructive pressures A small clutch one of 18 inches diameter for example capable of transmitting [illegible]0 horse power is apt to be regarded as a wonderfully efficient implement and so it is but it carries on its face the mark of its own destruction It cannot endure

Generalizing further we find that throughout the whole field of machine bearings pressure is a coefficient so to speak of endurance and good performance Exceptions may be pointed out in the case of slow movement but the rule holds good and has full recognition in the modern method of increasing the surfaces of bearings which is the same in effect as reducing the unit of pressure

Reverting again to the example named suppose that the [illegible] horse power is to be transmitted to a shaft revolving at a rate of [illegible]00 revolutions per minute and the friction clutch is to be substituted by a band This latter would for example be 10 inches wide on a pulley [illegible] inches diameter and the frictional contact surface be not less than [illegible]00 inches of area moving about 1 [illegible]00 feet per minute In the case of the friction clutch the area of frictional contact would be perhaps an eighth as much and the velocity half as much so the comparison of contact would be as 16 to 1 and the pressure to produce a given tractile effort would be in the same proportion If the pressure on the band was 2 pounds per inch that on the clutch would be 3[illegible] pounds per inch

These quantities are roughly assumed but as a matter of fact will I think come within the field of common practice One of the conditions is destructive the other is enduring but this is not all

Suppose the two means a band and a clutch are to perform the same work and to be *frequently stopped* and started the band to be shifted to a loose pulley for this purpose Here will arise a further distinction one of importance that has to do with both performance and endurance that is the time or rate of engagement or in other terms the control of pressure In the case of the band it must be shifted by degrees and by deflection edgewise to wind spirally upon the pulley to be driven the increment of area and consequent slipping which is an essential feature has to be cumulative and gradual avoiding overstrain and pressure It is true a clutch can be engaged in the same manner but it need not be—is not in any but exceptional cases

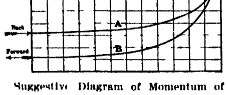


Fig 1 Suggestive Diagram of Momentum of a Reciprocating Table and Force of a Controlling Friction Clutch

OTHER DIFFICULTIES TO BE OVERCOME

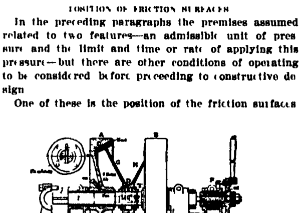
In the two features pointed out we can see the causes that have earned friction clutches their bad reputation There are other impediments such as centrifugal force frequent and unequal adjustment with more that could be named but the intensity of pressure and its irregular application account for a want of endurance the chief fault of friction clutches

This compendious screed is merely suggestive A complete analysis that embraced all the elements that enter into friction clutches would call for graphic illustration and consume more space than is at present at my disposal but the game is worth the candle if it will contribute to a new and improved form of these implements so widely demanded in modern constructive arts

POSITION OF FRICTION SURFACES

In the preceding paragraphs the premises assumed related to two features—an admissible unit of pressure and the limit and time or rate of applying this pressure—but there are other conditions of operating to be considered before proceeding to constructive design

One of these is the position of the friction surfaces These in practice can vary from radial or normal to the shaft to parallel therewith and do so vary in practice In the case of radial faces the pressure to engage a clutch must equal that on the frictional faces and this introduces what are commonly perishable devices, besides the wear at any point of the faces is as the speed at that point and is unequal tending to a curve of equal tangents as it is called



Figs 2 and 3 Suggested Construction of a Friction Clutch Engaging in a Predetermined and Controlled Interval of Time

Such clutches are employed only for light purposes because of the reactive strain on setting gearing so that some angle is chosen not only to reduce reactive strain but to secure concentric wear and more uniformity of surface speed

In clutches with their frictional surfaces parallel to a shaft and excluding embracing straps or brakes the usual construction is an expanding interior member with great pressure and toggle abutment against the center or nave also sometimes by coiling springs and in other ways but always with interior pressure and commonly metallic friction faces

These features may not at first seem directly relevant to the present subject but are so nevertheless if we are to reach a logical conclusion and circumstances point to frictional faces oblique to the axis of revolution and of such inclination as will permit instant and automatic release preserve concentricity and at the same time increase the unit of pressure by the wedging action Such an angle for these faces should be 20 to 30 degrees from the axis

SETTING OR ENGAGING MECHANISM

The next feature to be noticed is what we may call setting or engaging mechanism This must in all cases overcome a considerable resistance and in most cases sustain resistance through collars or what may be called running joints or bearings that are apt to lack endurance and involve a considerable mechanism

Taking into account the many and varied devices employed in setting we find that velocity and consequent wear is generally their fault and while the strains or pressure cannot be avoided we can reduce velocity by connecting through the axes of the shafts on which the clutches are mounted

This latter seems to be the best manner of operating friction clutches proved by its use in marine and other winches also in winding and hoisting machinery Reasoning inferentially there can be no doubt of the advantages possessed by this method of operating through the axes of clutches The details are reduced the pull can be compensated and the velocity slow enough to maintain collars on the setting rods

These remarks apply to any case where the ends of shafts are available which by proper design can be almost anywhere The subject is much wider in importance than would be imagined It brings to mind an incident of twenty or more years ago when a shrewd lathe man was observed stuffing his cap with waste and in reply to a question about headache said No it is those infernal friction clutches on the countershaft A piece comes down here every little while usually on the top of my head

In all these contrivances for setting clutches such as cones wedges toggles *et al* there are always pieces to come down come out or come loose and practice especially in hoisting and lowering gearing tends to the center rod and a through cotter connecting to the movable clutch member

Previous to any remarks here upon constructive features it is thought best to go over all the general premises and operating conditions This is not an easy way for either the reader or for me, but it is the best way to get at the subject understandingly

THE ENGAGING OF CLUTCHES

The next element or feature to be considered is the setting or engagement of friction clutches—the most interesting part of the problem and from which may come copious suggestion for construction

In most cases the work of the clutches, or the resistance it may be called, is regular or at least uniform and determinable, quantities that can be computed and demonstrated with their limit and degree. Opposed to this is the tractile force of the clutch, but the adjectives above do not apply to this, or at least are not applied to the setting or engagement of the clutches. This in many cases is performed by hand and without any rule whatever or any care.

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* American Machinist

There are however such a wide range of uses and adaptations that it will be necessary to assume a concrete example, such as the stopping and reversal of reciprocating machines—a metal planing machine for example, which at this time is the subject of extensive experiment among the makers of machine tools in this and other countries. It is in extended use and affects directly the cutting or effective time of working with such a machine. Obviously the manner of proceeding should be by constructing a diagram as in Fig 1, representing the two opposing forces, A the line of momentum for the mass or table of the machine and its load, and B the line of resistance by a friction clutch to overcome the momentum, stop and reverse the motion. All the quantities seem computable in a particular case, but this is not necessary here, so the diagram is of use only to illustrate what is meant and omits lines for inertia and reversing frictional resistance of the ways and so on.

From the features already discussed the reader will be in the way of plotting to some extent the line B after A is assumed, and is on the road of a logical solution and key to a suitable construction.

The line A as remarked is a definite and computable one from assumed or known quantities, and obviously the line B must be the opposite in degree or force, but must contain certain conditions or factors as follows: (1) maximum resistance required, (2) a limitation of force to guard against overstrain and accident, (3) a cumulative rate of resistance with increment as indicated by the curves, (4) how much the line B can be modified to save time without imparting shock or damage to the gearing and parts.

The last named factor is one of experiment, and introduces another of a constructive nature, namely adjustable means to change and regulate the resisting force in the line B. This has to be varied to suit different speeds now commonly provided for in metal planing machines, and requires setting by sound and sight, thus constituting a peculiar use but an extensive one that embraces all difficult conditions, and is selected for this reason.

It so happens however that the functions all fit within a fairly cheap and durable mechanism, as will now be shown by the drawing Fig 2.

A SUGGESTED CONSTRUCTION.

The diagram Fig 2 is prepared to show how the preceding features may be carried into operative effect. It is not intended for more, and admits of a wide range of constructive design. Following out these several features there is first the area of contact at C, taking into account the space and speed of right and left belts on A and B, the areas of contact are about equal, and the tractile force of the clutch and belts is about the same, not taking into account the reduced contact of the belts by reason of centrifugal force.

The pulleys or flywheels A and B form one member of each clutch, and with the inner members G and H have webs of angular section to increase stiffness, also to permit housing and protecting the parts. The parts G and H are practically but one, but are in two parts to house the cotter I, which slides on and drives the shaft J, which connects at J to the machine to be operated.

The clutch movement, which can be from ¼ inch to ½ inch, is by means of the central rod K moved by an oscillating screw nut that has a motion each way by hand or tappets, and is forced right or left by a strong spring and piston M that has a cumulative force each way, but regulation as to time and also as to range. The time factor is by means of a liquid in the cylinder M that must flow from the top to the bottom as the piston rises and as the clutches engage, the time being regulated by a screw valve N, seen in Fig 2. The liquid is free to flow upward by a floating valve in the piston as seen. Thus is provided an adjustable controlling force that is purely automatic.

The range of this engaging motion, or the extent of pressure that can be applied on the clutches, is determined in a like way by steps at F, which can be set accordingly. This is the time or rate of closing the clutches; it is fixed, and must by either hand or power occupy a certain period of time, otherwise they are liable to be jammed into action and injured. The distinguishing feature is that the clutches engage in predetermined time, and in this respect differ from all methods hitherto attempted so far as I am aware.

The angle for the frictional faces, their position and kind of tractile material, method of framing and indeed all the parts are the subject of varied constructive design so long as the principle or mode of operating is kept in view, remembering the subject is friction clutches to operate reciprocating machines.

It is suggested that reversing friction clutches should, like machine chucks, become an organized manufacture. No one wants to make such a device for a special use when the adaptation would be complete and the cost be half as much by an organized manufacture.

In preparing the example shown there was in mind belts five inches wide moving two to four thousand feet per minute, but in use the same machine could answer for two to ten horse power, a circumstance that especially favors organized manufacture.

A NEW VALVE GEAR FOR GAS ENGINES.

A SIMPLE MECHANISM FREE FROM BACK-ACTION.

IMPROVEMENTS in valve gears for steam engines are made chiefly with a view to obtaining greater economy in steam consumption; improved steam-engine valve gears aim at reducing clearances and giving a quick cut off.

The length to which inventors of valve gears will go by way of adding complication in order to achieve this result needs no comment.

That there are other worthy objects to be sought for, such as simplicity and fine governing, even in designing steam engine valve gears has sometimes been understood, and the most successful valve gears for steam engines are those in which a due regard has been given to these other things.

In a gas engine the consumption of gas is not affected at all by fine clearances and quick cut off, therefore improvements in gas engine gears are not so much directed to obtaining greater economy in gas consumption as toward simplicity of fine governing.

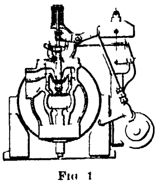


FIG 1

With this object in view the 'hit and miss' method is being abandoned in favor of some form of 'variable admission' gear, which admits a charge of greater or less value to the cylinder at every suction stroke.

This is effected either by a separate throttle valve in the mixture passage or the gas passage, or in both, or by automatically varying the opening of the gas, or inlet, or both valves.

Apart from employing a throttle valve there are in use two common forms of 'variable admission' gear—one operating on the main inlet, or mixture valve, and the other operating on the gas valve.

Up to the present the former type has been considered the simpler, the latter system being supposed to involve the adoption of two separate valve boxes and tackle.

Notwithstanding this, several makers of large gas engines, viz, the Nurnburg Co, Ehrhardt & Sehmer, the Cockerill Co.—to mention some—build their engines on these lines, putting up with the added complication involved rather than adopt a less correct system.

In addition to this system giving a constant high compression, thereby insuring more perfect combustion, it should be remembered that gears operating on the gas valve have only to open it against its comparatively light spring, thus causing a slight back action on the governor, whereas gears operating on the main inlet or mixture valve have to open this valve against the necessarily heavy spring which keeps it closed, thus causing a heavy back action on the governor.

The disturbing action on the governor of any positive action valve gear, we take it, is a fixed proportion of the resistance of the spring against which the gear operates to open the valve.

Therefore if fine governing is required, a gear operating on the gas valve is much to be preferred.

If a trip gear is used there is of course no disturbing action on the governor due to the opening of the valve, but when the gas or mixture valve is operated by a trip gear it is liable to rebound and cause clatter.

Another advantage of this system of varying the quality and not the quantity of mixture drawn into the cylinder is a quieter and smoother running engine, due to the engine always taking in a cylinder full of mixture for compression and having no tendency to suck open the exhaust and inlet valves, which can therefore be less heavily loaded, with consequent less wear of cams, etc.

Messrs Crossley have adopted a simple form of gear operating on the gas valve which does not involve a separate tackle to open the gas valve. It is arranged coaxially with the main valve and operated pneumatically.

The valve operating mechanism about to be described is similar to Messrs Crossley's, but the gas valve is operated mechanically.

The main feature of the new gear is that the gas valve, carried on the stem of the main inlet valve, is operated from the same cam and rod, but in such a manner that while the main valve always opens to the same extent, the gas valve opens to a varying extent determined by the governor.

The gas valve is arranged to close with the inlet valve, so that however small the quantity of gas admitted the mixture is always richest at the firing end of the cylinder, and in order to keep the constant volume of mixture sufficiently rich to insure combustion when running on very light loads, a ring on the bottom part of the gas valve partly throttles the air inlet.

Referring to the illustration (Fig 2), the main inlet valve A, is opened in the usual way by the lever B actuated by cam and rod from the half speed shaft.

The gas valve C is opened more or less by the levers DD, which pass one on either side of and connect with a swivelling crosshead L attached to the gas valve stem.

These levers have their fulcrum at F on arms GG, which are capable of being moved by the governor.

The levers at the other end are connected by a link H to the main inlet valve lever as shown. The spindle J, to which the arms GG are keyed, is connected to the governor by a lever and rod.

When the governor is in its top position the arms are in the position shown, with the fulcrum at F, and the opening of the gas valve is *nil*, there being no leverage.

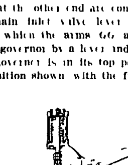


FIG 2

When the governor is in its bottom position the fulcrum of the levers is at F, and the gas valve has its maximum opening due to the leverage thus obtained.

The levers DD are made of such shape that whatever the position of the governor the gas valve is always closed when the inlet valve is closed. Also a small clearance at I between the levers and the swivelling crosshead allows the light spring at K between the gas valve and main inlet valve to insure that the gas valve shall properly seat itself when closed.

The resistance of this spring is the only resistance, apart from friction, against which the gear operates to open the gas valve, and it will be noticed that when the gear is in its worst position, viz, as shown in the illustration, the pressure on this spring is relieved due to the opening of the main inlet valve.

Fig 1 shows the gear in connection with Hall's patent frictionless governor, a description of which appeared in a recent issue. The gear is the invention of and has been patented by Mr H R Hall.—Page's Weekly.

A REMARKABLE AUTOMOBILE CHART.

A MECHANICAL SIGN POST.

Automobile tourists and that term includes about everyone who owns a motor car will be greatly interested in a new invention of Joseph W Jones which is a mechanical sign post

Briefly the invention is a revolving card whose rim is divided into 100 miles and tenths of a mile 176 yards to a division) On the other frame is a hand or pointer The map is set by a screw when starting to the place on the map where the trip begins As the automobile moves the map revolves slowly under the pointer At the end of 100 miles a new map is put on which shows the continuation

A long flexible driving shaft connects the map with the front of the wheel By perfectly adjusted gearing the speed of the road turns the 100 mile disc slowly under the pointer The chart and geared mechanism are protected by a case The flexible driving shaft makes it possible to pass the map for reference to passengers in the front seat or rear seats The map is carried in a leather attached to the brass rail and is supported by a frame so that it can be easily read from the tonneau By means of the flexible shaft the map may be either hung from the robe rail on the dashboard or carried in the lap as preferred As the wheels of the car revolve the map in the case turns a proportionate distance and it is always possible to tell where you are It is, of course necessary to follow the route prescribed on the route card but in case for any reason the driver makes a detour or takes a wrong road it can be reset in a moments time

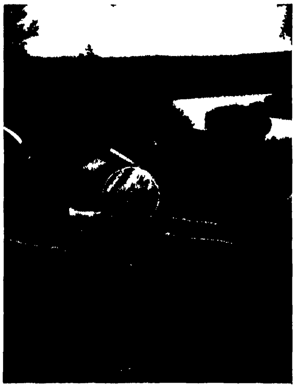


CHART AS USED IN THE TONNEAU

Route cards covering all sections of the country are to be furnished with the device

WIRELESS TELEGRAPHY NOT AFFECTED BY MAGNETIC STORMS

On September 2th 1909 the solar activity which had already manifested itself by sunspots and otherwise produced on the earth an aurora borealis and a violent magnetic storm which caused the declination needles of the magnetic observatories at Kew Paris and elsewhere to oscillate 1½ degrees on each side of the normal position This magnetic storm like its predecessors seriously interfered with the operation of those overland and submarine telegraph lines which use a single conductor and complete the circuit through the earth It is well known that the interruption of the service in such cases is due to irregular earth currents which are superimposed upon the telegraphic current and made the signals unintelligible These earth currents which are observed in wires the ends of which are connected to earth at points distant from each other show that the earth at such times is comparable to a sphere of moderate conductivity charged to a potential which varies from point to point The theory of these electric charges is still imperfect

On September 2 th last the telegraph service was interrupted not only in Europe but also in North and South America and in India where telegraphic communication between Bombay Calcutta and Madras was suspended for six hours All of the submarine cables were also affected Little disturbance was experienced however in lines running north and south The same peculiarity had been observed in several previous magnetic storms

During the whole magnetic storm even when it was most violent the wireless telegraph systems remained perfectly free from disturbance In the London Electrician Dr Eccles states that he operated a wireless station in Sussex for ninety minutes during the magnetic storm and not only received messages as clearly as usual but did not detect any abnormal frequency or intensity in the electric waves of unknown origin which are commonly observed

A Boutquin in a recent issue of Ciel et Terre lays stress upon the immunity from terrestrial magnetic disturbances which is fortunately possessed by wireless telegraphy and which he was the first to point out in connection with the still more violent magnetic storm of October 31st 1903 He adds that this fact should be taken into account in seeking the origin of these magnetic disturbances

These facts agree very well with the hypothesis that the magnetic perturbation is due to the influx of electrified particles or ions which are expelled from the sun and move toward the earth with a comparatively small velocity while if the electric influence were propagated from the sun to the earth with the velocity of light or electromagnetic waves (186 000 miles per second) it would be difficult to understand why it does not like electromagnetic waves of terrestrial origin, affect the apparatus of wireless telegraphy

RADIO-ACTIVITY OF ORDINARY MATTER

The experiments of Campbell who adopted a method of measurement more sensitive than that employed by Madame Curie indicated the probable existence of radioactive properties in potassium and lead Elster and Geitel have proved however that the radioactivity of lead is due to the presence of an impurity which is identical with radium F

Levin and Ruer who had also studied the radioactivity of potassium have recently extended their researches to most of the chemical elements They employed as detectors of radioactivity photographic plates wrapped in black paper on which were laid plates of brass 1 25 inch thick and 1½ inches square An opening about 1 inch square in the center of each brass plate was covered with a piece of silk paper on which the substance to be tested was placed The exposure continued about six months during which interval each plate with its accessories was inclosed in the cardboard box in which it was originally packed and kept in a dark room

In these conditions of total exclusion of light it was impossible to detect any difference in the slight darkening of the film beneath and outside of the brass plate This amount of discoloration was taken as a zero point in estimating the effects produced by the substances under examination A particular advantage of this method is the accumulation of the effect which makes it possible to use very small quantities of the various substances The method is sufficiently sensitive to detect a radioactivity one million times smaller than that of the α rays of radium

In the first series in the periodic table of the elements all salts of potassium and rubidium which were tested affected the photographic plates while no perceptible effect was produced by lithium sodium copper, silver or gold the salts of any of these metals or of ammonium or the nitrate of caesium

In the second series beryllium produced a very slight and doubtful effect while the salts of magnesium calcium strontium barium zinc cadmium and mercury proved inactive

In the third series the compounds of lanthanum were found to yield a very short lived radio-active emanation the suspected identity of which with thorium emanation could not be rigorously proved The other elements of this series boron, aluminium yttrium indium and thallium produced no effect on the photographic plates

In the fourth series four specimens of cerium compounds of diverse origin exhibited radioactive powers ranging from 1/10 to 100 times the radio-activity of potassium but as the most active specimens were found to contain thorium emanation, there is no evidence in favor of the radioactivity of pure cerium Experiments with specimens of lead, of which some were one hundred years old and others were taken from a Pompeian aqueduct revealed not a trace of radio-activity and thus confirmed the conclusions of Elster and Geitel The other elements of this series that were tested including carbon, in the forms of charcoal and graphite silicon, titanium, zirconium, tin and germanium, likewise failed to affect the photographic plates in the slightest degree

In the fifth series the only substances which unquestionably blackened the plates were salts of antimony and, even in this case the effect may have been caused by potassium salts present as an impurity The compounds of niobium tantalum and the metals of the rare earths gave uncertain results and phosphorus vanadium, arsenic and bismuth produced no effect whatever

In the sixth series sulphur selenium and tellurium in the free state and the salts of chromium molybdenum and tungsten proved inactive

In the seventh series neither the halogens in combination with sodium nor the salts of manganese, exhibited the slightest radio-activity

In the eighth series iron nickel cobalt and the metals of the platinum group proved equally inactive The effect produced by osmium and ruthenium in the form of powder appears to be due to chemical action

A few years ago the German engineer Otto Schlick, devised a plan for preventing the rolling of ships by placing in the hold a heavy flywheel and causing it to rotate very rapidly about a vertical axis Schlick's gyrostat was applied experimentally, to a German torpedo boat, with which very encouraging results were obtained, and it has since been employed successfully in a number of other vessels Nevertheless the invention is not yet so perfect or so well understood that favorable results can be predicted of its application to every new vessel The owners of a Scotch yacht of 241 tons on which a gyrostat was installed last year are about to transfer the instrument to a new yacht of 180 tons, because of its unsatisfactory performance on the larger vessel In comparatively smooth water the apparatus worked well on the large yacht and greatly diminished the rolling but when the force of the waves exceeded a certain limit the speed and consequently the stabilising action of the gyrostat were diminished by its very reaction to the rolling motion Hence it appears necessary for the gyrostat to be driven by a motor of power adequate for the maximum work required of it Another requisite is a practical system of regulating the power, instantaneously in accordance with the continually varying force of the waves

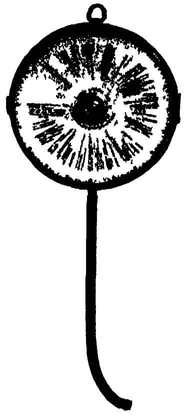


CHART ACTUATED BY A FLEXIBLE SHAFT AS SHOWN

From some experiments conducted by Prof Turner at the University of Birmingham some new observations have come to light pertaining to the subject of transparency in metals The only metal hitherto associated with transparency has been gold, but from the investigations of Prof Turner it has been discovered that silver and copper also possess this quality when subjected to the proper treatment While the observations are of no known practical utility they have attracted attention in scientific and artistic circles, as the color effects transmitted by the metals under such conditions are said to be of striking interest

THE GERMAN "DREADNOUGHTS."

WHAT IS THE "NASSAU" TYPE?

An extraordinary diversity of opinion appears to obtain as to the merits of the German dreadnoughts compared with corresponding vessels of the British navy. In Germany there are two distinct classes of opinion. One school holds that the Nassau represents the last word in everything. They point out that she brings as many big guns to bear as the Dreadnought in any position, and that she has in addition a 6-inch battery that is lacking in the British vessel, while her lesser speed is explained away by the argument that speed is for cruisers, not for battleships. Thus one view of the picture. Quite another aspect is given to it by retired German naval officers, who complain somewhat bitterly that the mountains have been in labor and produced a mouse. These officers argue that the vessels of the Nassau class are simply adaptations of the British Lord Nelson, and that they in no way justify the theatrical secrecy in which their construction was shrouded. They point out that the disposition of the artillery is such that there are always four big guns unavailable, and they ask somewhat pertinently wherein lies the triumph of carrying two more big guns than the Dreadnought and yet in not having a single extra gun to use. They admit circumstances in which the 6-inch batteries of the Nassau would be of considerable advantage, but against this contend that British dreadnoughts having the speed gage would be more or less in a position to choose the range, and would obviously maintain a distance at which the 6-inch gun was relatively useless. In fine, supreme disappointment would seem to be the dominant note with these gentlemen.

Between these two conflicting opinions the truth is probably to be found. When all is said and done, it cannot be claimed for the Nassaus that they represent any novelty. They are simply perfectly commonplace developments of the Deutschland class with big guns substituted for the 6-inch upper deck guns of those ships. Of novelty such as is embodied in the Dreadnought design there is nothing whatever, and it is further rumored on fairly good authority that they draw at least [illegible] feet more than they were designed to draw. This may be put down as a case against them. Of our own dreadnought it may, on the other hand, be said that they were produced on the assumption that the importance of the 6-inch gun was an exploded idea, and that the naval battle of the future would be entirely decided by the big gun. The more cautious Germans have accepted the big gun, but retained the 6-inch also so as to be on the safe side. The value of the 6-inch for battle purposes is one of those problems that only the next naval war can decide. But its utility as an anti-torpedo armament can hardly be exaggerated. That we have somewhat tardily realized this is perfectly clear from the fact that the 12-pounders of the Dreadnought gave place to 4-inch guns in later models, and in the Neptune to 4.7-inch guns. It is probable that upon these secondary guns the issue of a fight would be ultimately decided. The big guns in either design are so nearly equal that any battle result must depend upon gunnery pure and simple. The issue is therefore left to the secondary armament and its at present unknown value. It is, however, difficult for any unbiased critic to arrive at any conclusion other than that the German policy of "going slow" and retaining the 6-inch gun is the safer, even though that retention entails corresponding disadvantages, such as unduly increased draft and the overloading of a ship with more guns than she can reasonably be expected to carry upon her displacements. Our dreadnoughts represent a bold plunge into the unknown, likely either to be quite right or altogether wrong, whereas German design has proceeded on the principle of striking a mean so as not to be altogether wrong, whatever results the naval warfare of the future may produce.

This peculiar conservatism is characteristic of Germany, which has never believed in giving hostages to fortune. It is an old proverb that "nothing can be won without taking risks." In our dreadnoughts we have taken these risks with an almost abnormal candor. It rests with the future to show whether we were justified or not. Incidentally it should be remarked that up to the very last moment a very strong body of opinion in German official circles was in favor of a uniform secondary armament of 4-inch guns instead of the mixed 6-inch and 3.4-inch armament that has been provided. Even, therefore, across the North Sea absolutely definite opinions by no means prevail. But we feel that it is well that the public should realize that in our naval policy we have taken far bigger steps than other nations have been inclined to take, and that these facts cannot but add to the general sense of unrest that obtains. British naval construction to-day is by the force of circumstances of the nature of a vast experiment. We do not pretend to say whether that experiment is right or wrong. That the future may unhappily have to decide.—The Engineer.

THE PRESENT STATE OF THE PHYSICAL CHEMISTRY OF COLLOIDS

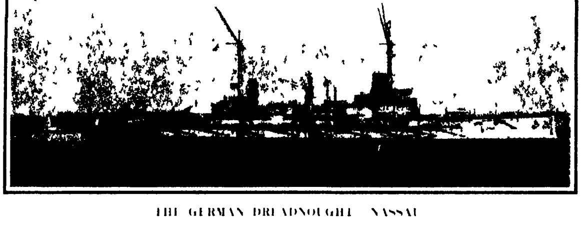
By A. Lottermoser.*

The laws which govern the behavior of matter in the gaseous state are peculiarly simple and universal. They may be briefly summarized as follows: 1. For a given mass of gas the product of volume into pressure is constant for a given temperature (Boyle's law).

2. With varying temperature this product is simply proportional to the absolute temperature (whose zero lies at −273 deg. C.). This is usually known as Charles' law or Gay Lussac's law.

3. When several substances in the gaseous state react with one another chemically, the *volumes* of the several substances taking part in the reaction are in simple numerical proportions. The discovery of this law also is due to Gay Lussac.

4. Lastly, the third of these laws, taken in conjunction with Dalton's law of constant proportions (according to which the masses which combine chemically are in simple numerical ratio) led Avogadro to enunciate the fundamental hypothesis which goes by his name, and which states that equal volumes of all gases (under similar conditions of temperature and pressure) contain the same number of molecules.



THE GERMAN DREADNOUGHT "NASSAU."

Mainly through the work of Pfeffer and Van't Hoff on osmotic pressure, it is well known that precisely similar laws hold for dilute solutions.

All these facts are harmoniously represented by a mechanical model, as it were, on the assumption that a gas consists of individual molecules flitting to and fro irregularly in the containing vessel, the pressure upon the walls of which is thus produced by the impacts of innumerable molecules. A very similar state of affairs appears to exist in a solution, although in this case the molecules are packed much closer to one another, and their path is accordingly changed in character.

Until a comparatively short time ago this explanation, though substantiated by a bulk of evidence, was still in a large measure hypothetical. But recent investigations of colloidal solutions have gone very far to establish the "kinetic" theory of matter, as it is called, upon a basis of almost direct evidence. For it has been found that the properties of colloidal solutions grade imperceptibly into those of the ordinary or true solution. In the latter it seems we have individual molecules of the dissolved substance distributed through the solvent. A colloidal solution contains similarly dispersed through it agglomerations varying in size from the ultramicroscopic to the microscopic. And the point of interest is that the microscopic particles actually exhibit plainly to the view the movement which according to the kinetic theory is characteristic of the ultimate particles of matter, the molecules. And more than that, this motion corresponds quantitatively (but for a constant factor) to that which calculation requires.

Colloidal solutions display a number of remarkable properties, some of which remain as yet unexplained. One phenomenon which had been early observed is that the dissolved or suspended material, the hydrosol, as it is called, tends to travel (migrate) through the solution if a difference of electrical potential is established therein. The direction of the migration relative to the potential gradient depends on the particular hydrosol selected. The particles of the hydrosol therefore carry electrical charges, and as a matter of fact these charges are essential to the stability of the solution; the introduction of electrolyte ions carrying an opposite charge may cause precipitation of the colloid. The question arises, what is the origin of the charge upon the particles of colloid? The answer seems to be furnished by the phenomenon of adsorption. It is well known that every solid adsorbs liquids and gases in proportion to the extent of its exposed surface. Very small particles will be particularly prone to this effect, since the ratio of surface to volume increases as the dimensions decrease. But the amount of any substance thus adsorbed depends also on the nature of the substance. A colloid dispersed through the solution of an electrolyte will therefore in general adsorb unequal proportions of positive and negative ions, and will thus become invested with an electric charge. By the addition to the solution of those ions of which there is a deficiency upon the colloid particles, the equilibrium can be so shifted as to just neutralize the charge upon those particles. The colloid is then precipitated. There is, however, a class of colloidal solutions which cannot be thus precipitated. They have been termed by Wo. Ostwald emulsion colloids. It is probable that these form a kind of cellular network through the liquid, and are thus distinguished from the other class, the suspension colloids, in which the individual particles are probably separate from one another. The emulsion colloids are not only themselves resistant against the influence of electrolytes, but are able, when present together with suspension colloids, to protect these in a measure from the precipitating action of the ions of an electrolyte.

The question naturally arises, how two hydrosols carrying opposite charges will influence one another. Experiment shows that mutual precipitation may occur, but only when the two colloids are present in a perfectly definite proportion. And the more pronounced the colloidal character of the two substances, the narrower are the limits within which the proportions must lie in order that precipitation may occur.

The precipitation of a hydrosol by an electrolyte is often bound to certain specific conditions. Thus if 48 c.c. of a twentieth normal solution of potassium iodide is added drop by drop to 50 c.c. of a twentieth normal silver nitrate solution, a positively charged colloidal silver iodide solution is obtained. The quantities are such that there is an excess of 2 c.c. of twentieth normal silver nitrate solution. This holds up the hydrosol and imparts a positive charge to it. If to this colloidal solution we add, say, one half or a c.c. of twentieth normal potassium iodide solution, no precipitation occurs, as there is still an excess of Ag ions which hold up the hydrosol. But if exactly 2 c.c. of such a solution is added, precipitation results. This effect is independent of the particular concentrations used, and depends only on the actual quantities. If, however, the limiting ratio is rapidly and considerably overstepped by adding three or four c.c., or indeed any large quantity of the twentieth normal potassium iodide solution, then again no precipitation occurs. At the same time the charge of the hydrosol changes from positive to negative. This effect, however, does not depend on the concentration of the solutions used. If the potassium iodide solution exceeds a certain strength, this overstepping becomes impossi ble and precipitation occurs as soon as the equivalent proportions are approached within a certain close limit.

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* Adapted from Zeitschrift für angew. Chemie, 1909, p. 141

Water is not the only substance that can serve as solvent for colloidal solutions. Similar results have been obtained with ether. Indications however are that absolutely pure ether would be incapable of functioning in this way. The explanation of this is no doubt to be found in the fact that pure ether is almost absolutely unionized. The presence of impurities such as traces of alcohol water etc furnishes the ions which as outlined above are necessary for the formation of a hydrosol.

We have noted that electrolytes can cause the precipitation of a hydrosol by supplying the requisite ions to neutralize the charge upon the colloid particles. The question may be asked whether in the absence of electrolytes a colloidal solution is stable for an indefinite period time. The answer is negative. As a matter of fact the larger particles slowly grow in size at the expense of the smaller and finally attain such magnitude that they settle out by gravity. This separation may be greatly accelerated by applying centrifugal action instead of relying upon gravity.

Here again it is interesting to note how gradual is the transition from colloidal to true solutions. Gravity is insufficient to cause any appreciable stratification in a true solution. But according to the experiments of de Bruyn this effect can be secured by centrifugal action.

It has been customary to suppose that the particles of the colloid in a hydrosol are amorphous. Latterly there has been a tendency to veer around to the opposite view. Zsigmondy has shown that the formation of the hydrosol can be initiated by the introduction into a suitable solution of a small quantity of the ready formed hydrosol. This action is strongly suggestive of the catalytic effect of crystals upon supersaturated solution and the inference seems rather obvious that the particles of hydrosol are crystalline.

Only a few of the more striking facts known today about colloidal solutions have been here presented. This comparatively new branch of physical chemistry has of late years grown with the force of an avalanche and there can hardly be any doubt that it is destined in the near future to bring further disclosures of the greatest theoretical and practical importance in chemistry and the allied arts and sciences.

STAMMERING.*

WITH SOME SUGGESTIONS AS TO MODERN METHODS.

BY G. HUDSON-MAKUEN, M. D.

It has been estimated that there are upwards of three hundred thousand stammerers in the United States alone. It is quite probable that about one fourth of the entire number would overcome their defect of their own accord or at least with the little help that always comes from interested friends but the remaining three fourths present a very different problem as that they must expend a great deal of time and energy upon the work of recovery and secure in addition the assistance of those having acquired a good working knowledge of the anatomy physiology psychology and pathology of the organs employed in the production of speech.

Stammerers are not alike except in a few characteristics and they require therefore a certain amount of individual treatment. Our experience with the one fourth of the entire number forms no criterion as to a basis for the general treatment of stammering but nevertheless because of the great ease with which these exceptional cases are managed inexperienced observers have reached false conclusions and formulated so called methods of treatment which are misleading fallacious and even absurd.

For instance a stammerer is told to nod his head whenever he speaks and because this procedure happens in his particular case to divert his attention sufficiently long to enable him to speak freely for a time he thinks he has made a discovery and he immediately evolves a theory and establishes an institute with a secret method which consists solely in nodding the head in unison with the natural rhythm of speech.

Another advises beating time with the forefinger and thumb or with the hand and arm or with the foot during the process of speaking and each one of these schemes has been dignified as a method which has been dispensed for a consideration and under bonds of secrecy. Experiences similar to this have generally been the starting point of the numerous methods which have been promulgated from time to time and which have resulted only in confusion to the many really severe stammerers who have been seeking relief.

There is even now a separate and distinct method which characterizes nearly every school and teacher engaged in this work and these methods in many instances amount to little more than tricks to beguile the stammerer into freedom of speech while his mind is preoccupied with something else.

It is well known of course that many people stammer under certain conditions largely because they think they will. All their past experiences with speech have combined to confirm them in the thought and it soon becomes a sort of fixed idea. It is nothing for which the stammerer should be censured because it is a perfectly natural consequence and the fixed notion that he will stammer under certain conditions will remain fixed until it has been supplanted by absolute confidence in his ability to speak freely under all conditions.

That this confidence can be acquired in nearly all cases is my firm belief but to be absolute the confidence must carry with it the ability. It is not enough for the patient to think that he can do it or even to know that he can do it but he must know that he knows he can do it. A stammerer is never thoroughly and permanently cured who has not so mastered the physiology and psychology of speech that should it ever become necessary he can recure himself. He must of course take heed lest he fall but should he fall he must be able to pick himself up again.

In reviewing briefly the history of the treatment of stammering we find that such men as Galen Celsus Klencke Dieffenbach Detmold Wolff and others supposing that the difficulty existed entirely in the tongue directed their attention chiefly to this organ and we have records of mechanical contrivances for holding the tongue in certain positions and such surgical operations as divisions of the hypoglossal nerve the lingual frenum and the various extrinsic and intrinsic muscles of the tongue. Dieffenbach went so far as to remove wedge shaped sections of the tongue. Galen cauterized it. Detmold passed needles through it. Klencke applied embrocations cauteries and blisters and Yearsley and Braid excised the tonsils and uvula. Others suggested holding cork between the teeth pressing the thumb on the chin lifting the tongue to the palate beating time as I have said with the head the thumb and forefinger the arm and the foot and numerous other such schemes. The story of Demosthenes struggling to speak with pebbles in his mouth is well known but the probabilities are that the pebbles might better have been left upon the seashore and that Demosthenes became a great orator not because of the pebbles but in spite of them.

I do not wish to be understood as characterizing all these practices for the cure of stammering as being fallacious for many of them may have some value in connection with a well ordered and scientific treatment. To suppose however that the tongue is chiefly at fault and to direct our treatment toward this organ whether the treatment consists in the application of mechanical contrivances the knife or what not is manifestly absurd and should not be thought of for an instant. The trouble is not so much in the tongue nor in the lips nor in the palate nor in the pharynx as it is in something back of them all. It is not so much in the peripheral as it is in the central mechanisms of speech. And thus it happens curiously enough that there is a grain of truth even in the theory and practice of surgery for the cure of stammering and it is found in the psychic impression of the operation.

I myself often think it fortunate on this account when there are tonsils and an adenoid to be removed a septal deflection to be corrected or an elongated uvula to be snipped but these are operations of course which always tend toward the betterment of speech whether or not it is of the stammering sort and they are operations too which are frequently indicated in these cases. I have been especially impressed with the large number of stammerers having intranasal pressure due to septal deflections and spurs.

History records also various educative methods for the treatment of stammering many of which are theoretically and practically sound. Making use of opposing movements in respiration and vocalization regulating tongue and lip action exercising patients on difficult words making use of rhythmic exercises and whispering exercises are among the most important but no one of these methods nor all of them combined can be regarded as a complete system for the cure of this affection.

The scientific treatment of stammering must have in view the actual substitution of normal speech for abnormal speech and its aim primarily therefore should be not the cure of the stammering but the development of correct speech. The cure of stammering should be regarded as of secondary consideration although of course it follows as a natural consequence. The stammerer's speech is faulty in every particular. His central as well as his peripheral mechanisms are out of gear and his mental attitude toward speech is wholly wrong. The instrument is out of tune and the player is unskilled in its use. He cannot retune his instrument and if he could he would be unable to play upon it. The affection therefore is a complicated one involving not only all the various mechanisms of speech but also some of the higher intellectual and emotional centers of the brain. Indeed it involves the whole being and its scientific treatment therefore must have for its purpose a thorough reeducation of the individual. It must supplant his stammering speech with normal speech. It must make it easier for him to speak freely than to speak hesitatingly. It not only must correct the stammering habit but it must remove the fear of stammering upon which much of the trouble depends.

If we correct the habit without at the same time restoring the patient's confidence in himself and in his ability to speak freely the cure will be only temporary and if we develop confidence in the patient by the use of the so called suggestive method whether it be given in the hypnotic or waking state without at the same time correcting the physical habits as is frequently done the results are only temporary and of course unsatisfactory.

It is not unusual to hear of stammering being cured in a few treatments or in a few weeks but it is quite unusual to hear of such rapid cures being permanent. It is possible in nearly every case by a short cut suggestive method to appear to cure stammering and hence it is that the commercially inclined stutter doctor is able to guarantee a cure and even to promise to refund the money in case of failure. A written guarantee of this sort is nearly always given in these institutes but no one has ever yet heard of the money being refunded although it is a fact that only a few of the patients are actually and permanently cured. On the other hand many of them are often made distinctly worse by their unfortunate experience.

The stammerer must be taught to speak in somewhat the same way as a person is taught to play upon the violin or the piano. The stammerer's instrument of course must be put in good condition by the removal of all obstructions to good speech and then as in the case of the would be violinist or pianist he must be taught to play upon this instrument. The exercises which are purely educational and physiological must continue for a sufficient length of time to enable the patient to form entirely new habits of speech and they must of course be adapted to the special requirements of each individual case.

Stammering in the majority of instances therefore cannot be cured in a few weeks. On the contrary it often requires several months or even years to bring about the desired results. The man who guarantees to cure stammering in six weeks or indeed who guarantees to cure it at all is either ignorant of the true nature of the affection or possessed of some ulterior motive and is therefore not to be trusted.

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* Read in the Section on Eye Ear Nose and Throat Diseases Medical Society of the State of Pennsylvania, Pennsylvania Session

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About a year ago considerable prominence was given to the approaching scarcity of commercial timber. Recent official estimates show that consumers have no reason to abate their efforts for the conservation of forest resources throughout the world. These indicate that in the United States the annual forest growth is less than one third of the consumption. In New Haven County for instance it is stated that for the year 1907, the timber cut was 120 000 cords, while the annual growth on all types of forest land reached the total of only 70,000 cords. The net reduction of 50,000 cords a year means that supplies of merchantable timber in the country will be exhausted in roughly twenty years.

HEAT AND MUSICAL PITCH.

THE INFLUENCE OF TEMPERATURE ON INSTRUMENTS.

BY THO. FAISST

In musical circles and especially among orchestral players it is regarded as an unquestionable fact that the pitch of an orchestra rises in the course of a performance often to so great an extent that toward the end of the concert or opera the sopranos and tenors experience unusual difficulty in producing their highest notes. The rise in pitch is seldom perceived by the auditors because the instruments are kept in tune with each other by frequent tuning so that the pitch of the entire orchestra is raised uniformly and gradually and it is impossible to compare the final pitch directly with the initial pitch. If such a comparison could be made the change of pitch would be very noticeable. It is generally assumed that the gradual elevation of the temperature of the auditorium during the performance has something to do with this rise in pitch but diverse and frequently absurd views are held regarding the connection between the two phenomena. It is often asserted for example that the dimensions of the wind instruments are directly affected by the increase in temperature but the exponents of this theory forget that the effect of heating would be an expansion of the instruments and that this would make the pitch lower not higher.

The writer was once able to make a direct comparison between the initial and final pitches during the production of a choral work in which the orchestra was supplemented by an organ. The pipes of an organ are divided into two principal classes known as flute pipes and reed pipes. At the end of this performance the pitch of certain of the reed pipes was distinctly lower than that of the flute pipes. The organ had been tuned very accurately before the performance when the air of the room was comparatively cool and it was evident that this striking discordance was caused by the subsequent elevation of the temperature of the auditorium. These organ pipes (a trumpet register) appeared to be too low because they were lower than the general pitch but more careful examination proved that they had preserved the initial pitch while the general pitch had risen.

The pitch of a reed pipe is determined mainly by the length breadth thickness and elasticity of its reed or tongue. It can easily be proved by calculation and experiment that a rise in temperature of 20 or 25 deg F such as would be likely to occur in such a case could not affect the dimensions or the elasticity of the metal tongue sufficiently to produce the observed discordance or even to cause a variation in pitch that the most sensitive ear could detect. Hence the reed pipes, though apparently flat really preserved the initial pitch of the organ and orchestra.

The pitch of an open flute pipe the sound of which is produced by the vibration of the column of air in the pipe without the aid of a vibrating metal tongue is equal numerically to the velocity of sound divided by twice the length of the pipe. Now the length of an organ pipe like that of a metal tongue may be regarded as invariable in practice but the velocity of sound varies appreciably with the temperature. At the freezing point this velocity of sound in air is about 1,100 feet per second and it increases at the rate of about one foot per second for each degree F of rise of temperature. This increase in the velocity of sound in air is due to the expansion and rarefaction of the air caused by heating it for the velocity of sound in a gas is inversely proportional to the square root of the density of the gas. As oxygen for example is 16 times as heavy as hydrogen the velocity of sound in hydrogen is four times its velocity in oxygen and an organ pipe filled with hydrogen produces the double octave of the note which the same pipe emits when filled with oxygen. The density of air and consequently the velocity of sound and the pitch of an organ pipe are affected by other conditions besides the temperature but we cannot stop to consider these conditions in detail. The humidity of the air for example plays an important part.

Now it can be shown by calculations based on the known laws of sound and gases and also by experiment that even the slight diminution in the density of air which is produced by a rise of 20 deg F in temperature is sufficient to raise the pitch of a flute pipe of the organ by an amount that is readily detected by a musical ear. If the temperature of the air is 59 deg F at the beginning and 77 deg F at the end of a concert as may very well happen the velocity of sound in that air is about 1,120 feet per second at the opening and 1,140 feet per second at the close of the performance and the pitch of the flute pipes rises in the same ratio of 1 to 1.0[illegible]. If one musical note is produced by a certain number of vibrations per second and another note by twice that number of vibrations the two notes are said to differ by an octave. That is the musical interval called an octave corresponds to a vibration ratio or pitch ratio of 1 to 2. In like manner a semitone which is the [illegible] octave corresponds to a vibration ratio or pitch ratio of 1 to 1.059 which is the twelfth root of 2. The number 1.02 is very nearly equal to the [illegible]th root of 2 hence the interval which corresponds to the pitch ratio 1 to 1.02 is about the [illegible]th part of an octave or more than one third of a semitone. This interval is easily perceived by an ear of any musical capacity and training. The writer has proved by experiment that the pitch of a flute pipe is raised a whole semitone by an elevation of temperature of [illegible] deg F. This result confirms the above calculation by which a rise *of one third of a semitone was deduced from an elevation of 18 deg F.*

A similar effect is produced on those orchestral instruments (flutes for example) which are constructed on the same principles as the flute pipes of the organ. When a flute which has been kept in a cool room is brought into a warm room and played upon its pitch quickly rises so that it becomes necessary to draw out the extension tube. At first the air which fills the flute is chilled by contact with the cold instrument but this chilling does not take place after the flute has become warm.

An interesting observation confirmatory of the preceding statements can be made when a band playing indoors on a cool evening is accompanied by an echo played out of doors. In these conditions the echo always sounds flat no matter how accurately the echo players have tuned their instruments before leaving the warm concert room.

In orchestral wind instruments with the exception of flutes however the conditions and phenomena are not quite so simple as they are in the case of the flute pipes of the organ. Even in the reed pipes of the organ a complication is introduced by the fact that neither the reed nor the column of air in general vibrates freely in its natural period but the two are brought into forced unison by their influence upon each other. The conditions are still more complex in oboes clarinets etc and also in horns and trumpets in which the place of the vibrating reed is taken by the tightly stretched lips of the player. The temperature of the air which is blown into the instrument from the lungs does not vary to the same extent as the temperature of the air of the room. If the latter is [illegible]0 deg F the former will be about 9[illegible] deg F but if the temperature of the inhaled air is raised 18 degrees to 68 deg F that of the air expelled from the lungs will be raised only about 3½ degrees to 98½ deg F. Hence the effect of variations in the temperature of the room is much smaller with these instruments than it is with the flute pipes of the organ. The effect also varies according to the character of the instrument. For these reasons it is very difficult if not impossible to keep an orchestra in tune in an overheated room.

When the cause of the discordance is understood however the evil can be obviated to a considerable extent. In the case of the organ it is necessary in the first place to keep the air blown into the pipes always at the same temperature. Hence in winter the bellows room should be provided with adequate means of heating so that the air employed in tuning the organ when the room in which the organ stands has a temperature of perhaps [illegible]0 deg F may be heated to about [illegible]0 deg F the temperature which the auditorium may be expected to attain during the performance.

The best method of keeping the orchestra fairly in tune with itself and with its initial pitch consists in keeping the auditorium as nearly as possible at the *temperature which it had at the beginning of the performance* when the instruments were tuned. This result can best be secured by carrying off the excess of heat by means of thorough ventilation. Moderate temperature and pure air exert as favorable an influence upon the physical tone of the instruments as they do upon the mental and moral tone of the musicians and auditors. Hence there are aesthetic as well as hygienic reasons why far more attention should be given to the ventilation of concert halls than this important and difficult problem usually receives.—Prometheus.

THE FREQUENCY OF HEART BEATS IN THE MOUSE

It is well known that the frequency of heart beats in general is approximately in inverse proportion to the size of the animal. For example the number of heart beats per minute is 30 in the elephant 40 in the horse, 50 in the ass and mule 70 in man 90 in the dog 150 to 200 in the rabbit. The difficulty of counting the heart beats when their number exceeds 200 per minute and the almost insurmountable difficulty of registering them with any apparatus now in use has hitherto prevented exact measurement of the frequency of heart beats in very small animals. Such a determination has now been made by F Buchanan who had been led by theoretical considerations to the conclusion that the frequency of the heart beat in the mouse could not be less than 500 per minute. In order to test the correctness of this conclusion he recorded the electric variation produced by the contractions of the heart. This he accomplished very easily by plunging the fore feet and the hind feet of the mouse which was suspended by an abdominal bandage into two solutions which acted as unpolarizable electrodes and were connected with an electrometer the oscillations of which were recorded by photography upon a moving strip of paper. The number of heart beats per minute was found to be between 520 and 675 in 3 mice weighing about one ounce each, between 720 and 780 in 2 mice eight weeks old, weighing between one-half and three-quarters ounce each and 680 in a white mouse weighing one half ounce. The mean value obtained from all the observations was 670 pulsations per minute.

The respiration of mice is also very rapid 110 to 160 per minute according to Buchanan's observations. Hence the ratio between the frequencies of heart beat and respiration is about four as in man and most mammals. The heart of the mouse beats four times as rapidly as that of the rabbit and ten times as rapidly as the human heart.

TO MAKE LIME WITHOUT A KILN

It is possible to make lime without a kiln and this method deserves to be more generally known and practised than it is. The proportion of coal used is not greatly increased by the suppression of the kiln but the time required for burning is prolonged. On the other hand the cost of the kiln is saved and the cost of transportation can be reduced to a minimum. The proportions of coal and limestone required vary greatly according to the quality of both materials and the skill of the lime burner. It is always better to use too little coal than too much. In the first case some of the limestone is left unburned and must be treated again, in the second case especially if the fire is very brisk the silicates associated with the limestone may melt and protect a large proportion of the carbonate from the action of the fire. A carload (10 tons) of coal is often sufficient for 50 cubic meters (6[illegible] cubic yards) of limestone.

The first step in the operation is to clear smooth and slightly elevate in the center a circular area about 16 feet in diameter. A circular pit about 3 feet in diameter and 20 inches deep is dug in the center of this flat mound and connected with the circumference by a trench of the same depth and of the width of the spade. The fire is lighted by means of this channel. The central pit is filled with successive layers of straw kindling wood and logs and the whole area is then covered with flat stones for the purpose of preventing the walls of the pit from caving in. Upon the foundation alternate layers of coal and limestone are laid the latter nearly five times as deep as the former. The pile is made sufficiently tapering to insure stability and is completed by a top layer of limestone. It is then covered with successive layers of flat stones sod and mud. In building the pile several air passages are left on the windward side at the bottom and on the leeward side at the top. The pile is lighted by introducing a torch fastened to a long pole through the trench to the straw in the central pit. When the fire is well started some or all of the air passages may be closed. It is even advisable to stop any crevices which may be formed in the outer covering. The time required for burning the pile may vary from a few days to three weeks according to the quantity of air admitted. It is advisable to conduct the operation slowly, in order to prevent the fusion of the silicates

PARIS AND ITS TUNNELS

The proportions of the disaster which has overwhelmed France and especially Paris can hardly be estimated as yet. One quarter of the city was inundated on January 27th and one quarter more was rapidly being flooded from sewers which were backing up as the Seine continued to rise. The loss already is estimated at $[illegible]00,000,000 and this is called conservative. The Palais de l'Elysée, the residence of the President of France, has its cellars inundated.

In the old Latin quarter the situation was critical. The sidewalk of the Quai des Grands Augustins collapsed and fell into the Orleans company's tunnel beneath, further extending the flood through the ancient streets, particularly the rue Jacob and around the Institut de France. Another bad cave-in occurred in the rue de Tournon. Half an hour later the water forced its way up through the subway workings in the rue St. Lazare, which was inundated the whole of its length. In several places the sidewalk fell in. The subway under the Place de l'Opera collapsed.

Many houses were hurt in the Twelfth arrondissement, one of the biggest in Paris, the whole of which was submerged. Masons were hastily summoned to erect a wall to save the historic Hotel Lambert, erected in the seventeenth century and now the residence of Prince Czartoryski, and the equally famous Hotel Lauzun adjoining, which was purchased by the city in 1900 to be used as a museum of art. It also was built in the seventeenth century.

The Ile de la Cité, where the famous Cathedral of Notre Dame and the Palais de Justice stand, was changed into a vast lake. The Gare Saint Lazare stood over a big subterranean lake.

The American and German Embassies were flooded and water poured into the cellars of the British Embassy, the convents and public buildings, including the Pantheon, which was turned into a refuge for the homeless of Auteuil, Alfortville, Maisons Alfort, Charenton and other outer sections.

The tunnels of Paris naturally played so prominent a part in this widespread inundation that a description of them may be of some interest.

The lines which compose the Paris Metropolitan are nine in number. Following is a list of the lines in the order of construction: 1. From the Porte de Vincennes to the Porte Dauphine, with a connection to the Porte Maillot. Circular line starting from l'Etoile and following the outer boulevards. Ménilmontant to the Porte Maillot. It separates from the two preceding lines at the Rue de Constantinople and passes through the Rue de Rome, the Boulevard Haussmann, the Rue Auber, Quatre Septembre, Réaumur, Turbigo and Temple. From the Porte d'Orléans to the Porte Clignancourt. This is the north-south transverse line. Boulevard de Strasbourg to Pont d'Austerlitz. It connects the Place de la Bastille to the circular line. Boulevard de Vincennes to Place de l'Italie. From the Place Valhubert to the Quay de Conti. Palais Royal to the Place de la Danube by the Rue Lafayette. From l'Opera to Auteuil by the Place de la Concorde and the Invalides.

All these lines comprise two systems, a number of transverse lines and a circular line, with other short lines connecting them together at various points.

The total length of the first six lines is about sixty miles, forty of which are underground, ten in cuttings and ten on viaducts. The power is supplied from three stations at Vaugirard, Charonne and Montmartre. The Place de l'Etoile is a sort of central station. Under its roadway the tracks branch out in all directions.

We will describe the Etoile-Trocadero line first, as it is the chief of the Etoile lines. Its track circles around the Place de l'Etoile so that the trains coming in round the curve and return by a descending line of track without any switching. This arrangement facilitates the movement of trains and reduces quite considerably the time of stopping at the terminus.

The Porte Maillot-Champs Elysées line traverses Place de l'Etoile and touches tangentially the curve of the preceding line at a point near the Avenue Wagram. The third line, called the Porte Dauphine-Avenue Wagram line, passes under the other two and its rails is [illegible] feet below the surface of the ground. There can be no junction of this line with the Porte Maillot-Champs Elysées line because of this fact, but the stations are built in the same vertical plane so that passengers can transfer without going to the surface.

The method of excavating adopted was very simple. The contractors dug pits at intervals through which the earth was raised to the surface as the tunnel was excavated. They made as many of these pits as possible in order to increase the number of working places and thus to reduce the length of time required to complete the work. Some contractors used hydraulic shields, which, notwithstanding their high cost of $[illegible], were found to be economical in the long run. By their use the amount of woodwork necessary to hold up the beams of the galleries was considerably reduced.

The shield sometimes took in the whole cross section of the tunnel, which was then constructed at a single operation in successive rings. At other times only the arched roof was cut out with the shield, after which it was necessary to excavate the tunnel down to the level of the roadbed. Whichever way it was used, the role of the shield was not to pierce the earth but to sustain the roof for the time being. The workmen were placed in front of the shield, where they work with pick and shovel, preparing the way for it. When this had been done, the hydraulic rams which bore against the woodwork of the tunnel were operated and the shield forced forward, so that the earth was filled up by a metallic ceiling. The hole behind it was immediately bricked up.

Unfortunately the shield could not always be used and there were places where recourse was not to be had to it, as for instance in the curved sections.

There are two types of stations. Where the tunnel is far enough below the surface, it is either bricked up as in the Place de la Nation, [illegible] places, as at the Palais Royal and the [illegible]. [illegible] water was encountered and the [illegible] bring the tunnel as near to the surface as possible.

In the Metropolitan system the Seine is crossed six times, to wit: At Bercy by line No. [illegible], which has become the prolongation of the circular south line; at Austerlitz by line No. [illegible]; at City Island by line No. 4; at La Concorde by line No. [illegible]; at Passy by the south circular line No. 2; and finally at Auteuil by line No. 8 for the second time, without counting the crossing at La Concorde of the North-South line conceded to Lamarre Berlier. In order to effect the passages two methods are offered: the bridge, known from ancient times, and the subway, the use of which under such circumstances dates back to [illegible]. Whenever it was not inconvenient to establish viaduct lines, bridges were employed.

What was possible at Bercy, Austerlitz and Passy, where bridges have been widened or constructed, was totally impossible at Chatelet [illegible] in order to form the passage of line No. 4 from the gate of Clignancourt to the gate of Orleans under the Seine and City Island the special arrangements were made.

Among such works there are [illegible] that have been particularly remarked. In the three places, the Place Saint Michel and Place Saint André des Arts were dug up and in the trench formed a station was constructed. In order to pass under the Seine and City Island there had to be substituted for the ordinary masonry tubing of the current type of subway, for a distance of [illegible] feet between the Chatelet and Boulevard Saint Germain, a metallic tubing formed of cast iron voussoirs assembled by bolts. In the subfluvial part corresponding to the passage under the small and large arms of the river, the tunnel thus constituted was further inclosed by sections [illegible] feet in length in metallic caissons of semi-cylindrical form, constructed upon the shore and then transported to the site, lifted and sunk vertically until they reached a level such that the distance between the roof and mean level of the water is [illegible] feet. For traversing the land not situated under the Seine but likewise covered by water, a horizontal tunnel was constructed by means of a shield and compressed air. Recourse was had in addition to a very curious process of execution for the passage under the Orleans railway at Place Saint Michel, that of a preliminary freezing of the ground, in order to permit of constructing the Metropolitan line without any danger of the subsidence of the work overhead.

The crossing of the Seine comprised, in addition, the establishment of two stations, one of them at the Flower Market and the other at Place Saint Michel. Being destined to rest upon water-soaked ground, they could not be constituted or constructed like ordinary stations. By reason of their excessive dimensions the possibility of using a shield under such circumstances could not be thought of, and so recourse was had to the use of caissons sunk vertically.

The caisson had the appearance of a coverless box, which in most cases was metallic and, with its water-tight walls entirely enveloping the work to be constructed, mounted upon the shore when it was to be had to traverse only wet ground, and provided at its base with a working chamber to permit the laborers to prepare the way for the caisson and its contents, which they had to let down to a definite level and which sank progressively by its own weight in measure as the soil was removed.

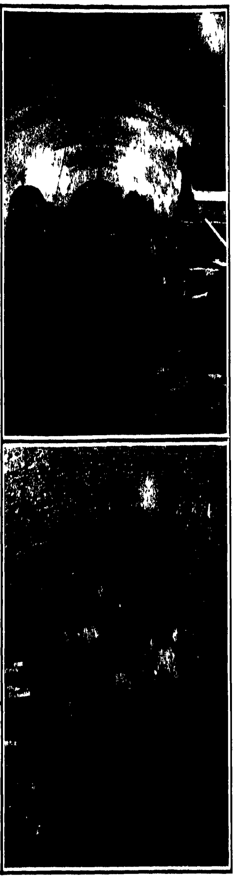
Each of the stations under consideration, both curved (the City of 1,9[illegible]0 feet radius and the Saint Michel of 984 feet), is composed of three caissons forming a unit 38[illegible] feet in length and arranged as follows: In the center a caisson [illegible] feet in length containing the station properly so called, and at each extremity an elliptical well connecting the station with the subway, of a height equal to the distance existing between a point situated at [illegible] feet below the lower part of the station and the level of the street, and designed to contain, in addition to a ticket office, means of access (stairs and elevators) to the passenger platforms. The work at Place Saint Michel was therefore done in connection with the construction of the station of that name.

THE NEW SUBWAY WHICH SUPPLEMENTS THE METROPOLITAN LINE IN PARIS.

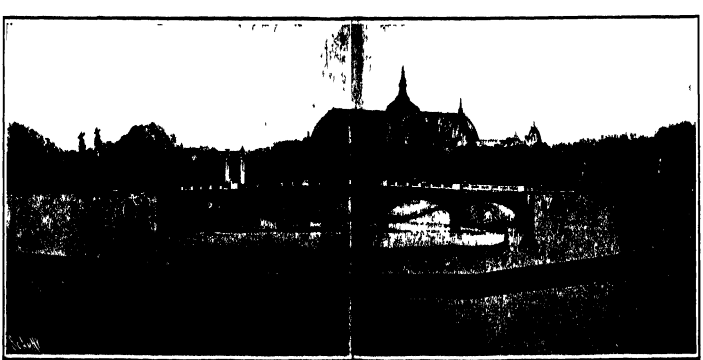
Paris has found that the providing of transportation has led to a demand for more. To relieve congestion an underground railroad about 8½ miles in length is being driven under the city from north to south. This line taps districts at present but poorly served by the Metropolitan lines of communication and links existing lines. Apart from its necessity, the line has created great interest in Paris because it burrows under the river Seine. Railways already bridge the stream, and a subaqueous tunnel has been constructed of a number of caisson sections which are sunk in the bed of the stream. But for the present tunnel the engineers are adopting the shield and compressed air in order to burrow under the river. The engineers have faced a number of delicate problems in their construction of the line and have successfully solved them.

A SECTION OF THE NEW SUBWAY SHOWING HOW WALL THICKNESS HAS BEEN SAVED IN CONFINED SPACE BY THE USE OF CONCRETE. IN PLACES THE SUBWAY TRAVELS UNDER NARROW STREETS AND IT IS NOT PRACTICABLE TO EXTEND ITS BREADTH SO AS TO ENCROACH UNDER THE SHOPS OR HOUSES. HENCE THE SIDES AND VAULTING OF REINFORCED CONCRETE.

SECTION SHOWING A STATION ON ONE OF THE OLD LINES WITH THE THICKNESS OF THE MASONRY.



TWO STAGES OF THE WORK OF CONSTRUCTING THE NEW PARIS SUBWAY. THE DISTANCE BETWEEN CENTERS OF THE TWO TUBES VARIES FROM [illegible] TO 43 FEET. HENCE THE TWO TUBES ARE NOT EXACTLY PARALLEL. THE TUBES WERE RUN UNDER THE RIVER SEINE BY MEANS OF THE AMERICAN SHIELD AND COMPRESSED-AIR METHOD.

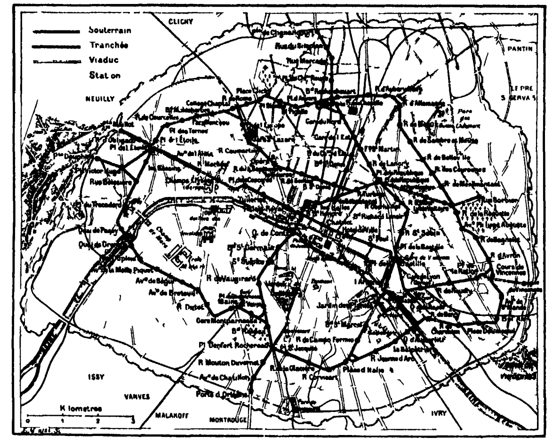


THE PROFILE OF ONE OF THE NEW STEEL TUBES UNDER THE SEINE. THIS IS THE FIRST TIME THAT A EUROPEAN RAILWAY TUNNEL HAS BEEN DRIVEN UNDER A RIVER BY THE AMERICAN COMPRESSED-AIR METHOD. THE ENTIRE LENGTH OF THE STEEL TUBE SECTIONS IS 1,764 AND 1,797 FEET RESPECTIVELY. THE TWO TUBES HAVE A SLIGHTLY DIFFERENT PROFILE.

In addition to the Metropolitan there is in construction another subway line. The new road is laid out somewhat upon the same lines as the Paris Metropolitan subway, and makes connection with the latter at different points so that the cars may shift from one road to the other. This new subway line will run in a north and south direction across the city. It will take a district which is not covered by the Metropolitan and will connect the southern quarter with the central part of the town.

The total length of the line, which is entirely underground, is about eight and one-half miles. It comprises the main line, which runs from the Versailles gate, proceeds northward past the Montparnasse depot, then crosses the Seine in tunnel, running thence under the Metropolitan subway and past the St. Lazare depot, finally reaching the northern terminus at the Place Jules Joffrin. At the St. Lazare depot starts a short branch tunnel which passes by five stations and ends at the St. Ouen gate. The main line has twenty-three stations, making twenty-nine stations on the entire route. The tunnel section and the stations are laid out on about the same plan as for the Metropolitan double-track system. There are two special features of the new road. One of these is the steel tube under the Seine, and the second, the underground stations built of reinforced concrete.

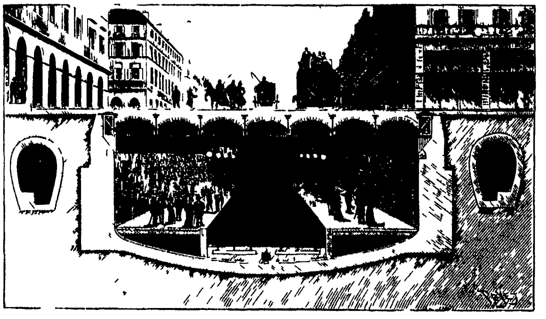
As in the case of the Metropolitan, one of the principal points which occupied the attention of the engineers was that of taking the subway line across the Seine. The engineers [illegible] under the river by the shield and compressed air method introduced in France some time ago in order to take two large sewers under the river. The general course and the profile of the construction is shown in one of the sectional views, which shows the tunnel in its completed state. There is a double tube under the river bed, each tube carrying one of the tracks of the road, which are standard gage. The single tunnel which approaches the river on the south bank, and which is of standard section for double track, ends at a large underground station lying near the river at Rue de l'Université. At the other end of this station start the two parallel sections of the steel tube. The two tubes at first run under the street for some distance and then pass below the Seine in an almost parallel path. Coming to the other bank the tubes diverge somewhat and then are brought together and enter a second station. This latter forms the end of the tube section. From the farther end of the station the standard double-track tunnel resumes its course toward the northern part of the city.



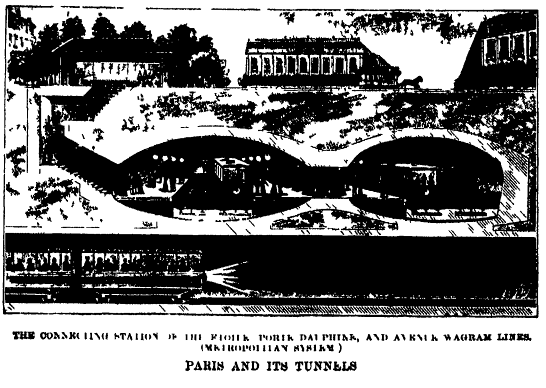
MAP OF THE PARIS METROPOLITAN RAILWAY.

The entire length of the steel tube sections is 1,76[illegible] and 1,797 feet respectively between the two stations. The two tubes have a slightly different profile, and the tube lying up stream starts from the Université station at a down grade of 4 in 100, and on reaching the river the grade becomes nearly level at [illegible] per 100. Toward the other bank the line mounts again at a grade of [illegible].51 per 100, with a total length of 538 meters (588 yards). The second tube differs very slightly in level, and its length is 548 meters (599 yards). Both of the tubes have an inside diameter of 5.00 meters (16.4 feet) and an outer diameter of 5.24 meters (17.2 feet). The center of the tube is 1.40 meters (4.6 feet) above the rail level of the track. The tube is formed of a series of cast iron rings 2 feet broad, bolted together by 1-inch bolts through flanges. Each of the rings is made of curved cast iron pieces forming voussoirs after the manner of arch construction. Around the circumference there are twelve voussoirs, including the key piece, which is shorter than the rest. There is a space left between the voussoirs of each ring and also between the different rings of the tube of 5 millimeters (0.20 inch), and the space is filled by a thin piece of creosote wood, poplar or pine, on the outer side, the inner part being then filled up with a calking of Portland cement mortar. The thickness of the walls of the tube is one inch of metal in the thinner part, this being reinforced by the webs of the voussoirs, which make the total thickness across the web to be 5 inches.

One of the original features of the present plan consists in the use of reinforced concrete for the underground stations. This was required in some cases where the streets were very narrow and the station could not be built in the ordinary way without an excessive cost of expropriation. In order to build the stations without interfering with the walls of the houses the present method was adopted, and in the case of the Rue de Vaugirard, which is only 15 meters (49.2 feet) wide, an underground station 41.6 feet wide has been built without infringing upon the adjacent property. Instead of 7½ feet for the station wall the reinforced concrete occupies a thickness of only 2 feet. The vaulting is only 18 centimeters (7 inches) thick, but is reinforced by webs which are designed so as to lie partly on the inside and partly on the outside of the vault.



THE STATION AT THE PLACE DU PALAIS ROYAL.



THE CONNECTING STATION OF THE ETOILE, PORTE DAUPHINE, AND AVENUE WAGRAM LINES. (METROPOLITAN SYSTEM.)

PARIS AND ITS TUNNELS

THE LOS ANGELES AVIATION MEET.

By Cleve T. Shaffer.

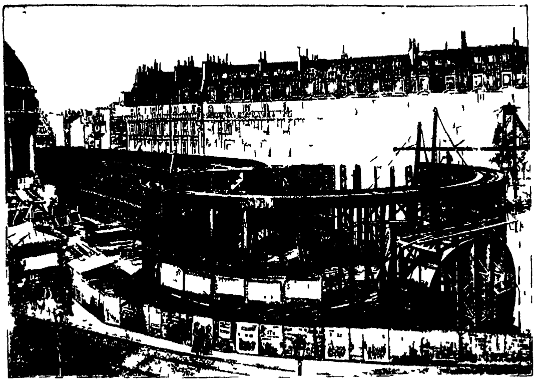
The Los Angeles Aviation Meet, while a wonderful exhibition of flying to a part of the world in which flying was a novelty, was in fact nothing more than an exhibition. As a meet it lacked the contest spirit manifested when a great number of machines of a diversity of type are brought together, such as at Rheims.

But four aviators qualified and but two types of machines were successfully used—the Farman and the Herring-Curtiss, both biplanes. The Bleriot monoplane made a miserable showing for reasons mentioned hereafter. This lack was also due to the fact that all the aviators present were under contract for a cash guarantee. As a result of this, the meet lost its sporting flavor and consequent zest.

The rules were arranged so that there would be no fixed programme of events for each day, but every day the aviators could try for any of the prizes if they were ready with their machines and found the weather propitious.

With these liberal provisions there was no real excuse for the scarcity of daily flights except that the machines were not capable of more than one or two short flights a day, or that the operators were simply making exhibition flights or demonstrating their machines.

The following list of prizes won will give our readers a good idea of what was accomplished by the aviators:



THE END [illegible] CAISSON WHICH WAS SUNK AT PLACE SAINT MICHEL.

HEIGHT.

On January 12 Paulhan broke all world's records for height, reaching an altitude of 4,1[illegible] feet in his new Farman biplane, which is considerably smaller and over 200 pounds lighter than the regular Farman machine, thus winning the height prize of $ 000. An Aneroid barometer carried by Paulhan registered 4,100 feet, but the figures officially taken were those of the engineering squad which measured the ascent. By this performance Paulhan won the first prize of $ 000.

Chas. K. Hamilton received second prize of $ 000, going up on the last day to an altitude of 6 6 feet on his Curtiss biplane fitted with a four-bladed propeller. Curtiss received the third prize of $ 00. No official height was taken.

SPEED.

In the speed contest Glen Curtiss was, as at Rheims, the winner in his 8-cylinder machine. He won the first prize of $3,000 in the ten-lap event (16.11 miles), going the distance in 23 minutes 43 2/5 seconds, an average speed of 40.71 miles an hour.

Paulhan took second prize of $2,000, being over a minute behind Curtiss' time, and covering the 10 laps in 24 minutes [illegible] 2/5 seconds.

Hamilton received the third prize of $500, his time being [illegible]0 minutes 34 3/5 seconds.

Curtiss made a one-lap (1.61 mile) track record of 2:12, which is a speed of 43.[illegible] miles an hour.

ENDURANCE AND TIME.

Louis Paulhan easily won the endurance and time prize of $3,000, going 75.77 miles in 1 hour [illegible]8 minutes [illegible]2 seconds, a leaky gasoline tank preventing further effort.

Curtiss on the last day partially redeemed his lost prestige by making a decided effort to beat Paulhan's record. An accident to his machine caused him to descend after having made 37.0[illegible] miles in 1:2[illegible]:0[illegible] (26.1 miles per hour), thus winning the second prize of $2,000. Paulhan was at the same time endeavoring to lower his own record, and had the satisfaction of seeing his rival compelled to descend. He followed himself a little later on account of darkness, after covering 40 laps of the course.

Hamilton won the third prize of $ 00, covering 19.44 miles in [illegible]9 minutes 2[illegible] 3/5 seconds ([illegible]0 miles per hour).

STARTING AND LANDING IN SQUARE.

Willard, in the Aeronautic Society's Curtiss biplane, made a very pretty start and finish in a 20-foot square. Starting some distance back and rising when in the square, he circled around the track and landed with one wheel just an inch off the line, thus winning a prize of $250. In this sort of a trial a brake such as is used on the Curtiss machine is a necessity.

SLOWEST LAP.

This prize of $500 was won by Hamilton, who covered the 1.61 miles in 3 minutes [illegible]6 2/5 seconds. Willard, in a trial for this event, slowed his motor too much and was compelled to drop.

QUICKEST START.

This prize of $250 was won by Glen H. Curtiss, who got off the ground in 6 2/5 seconds from the start of the motor. Curtiss thereby broke his former record. He also broke the world's record (his own) for distance required in starting. The distance to the place where the rear wheels left the ground was but 98 feet. These records were made January 11th.

THREE LAPS WITH PASSENGER.

Prize, $1,000. Won by Paulhan, who covered 4.8[illegible] miles in 8 minutes [illegible] seconds ([illegible] miles per hour).

Curtiss carried a passenger several times in his 8-cylinder machine, but did not attempt more than one lap. His passenger seat is placed below and at the left of the operator, and while off center he has no apparent difficulty in manipulation.

Paulhan took up many passengers during the 11 days, sometimes carrying two with ease.

CROSS-COUNTRY FLIGHTS.

The [illegible]-mile cross-country flight to Arcadia and return, [illegible]½ miles each way, was a truly wonderful and significant spectacle. A feeling of awe pervaded all who witnessed him gradually disappear into the beautiful background of snowy mountains. His reappearance was no less marvelous, as the tiny speck high in air above the white peaks materialized second after second into man and machine. Prize won, $10,000.

Paulhan made in all four cross-country flights, the three others being unofficial.

The first, from Aviation Field to San Pedro and return, was [illegible]1¼ miles.

The third, to Redondo Beach and return, [illegible]1¼ miles, is remarkable because of its being a passenger flight, Mme. Paulhan accompanying him. This is a record for a flight across country with a passenger.

Trip number four was also a passenger flight in the same direction, with C. B. Harmon on board. The distance was 1[illegible]¾ miles.

Hamilton, after making his height record on the last day, made a short cross-country flight at about [illegible]0 feet elevation, which latter was fortunate, as on his return, while still outside the grounds, his crank shaft broke, his height enabling him to glide into the aviation field without injury.

The dirigibles of Knabenshue and Beachy were brought out every day, but their slow speed and unwieldy bulk limited their maneuvers to hours of good weather.

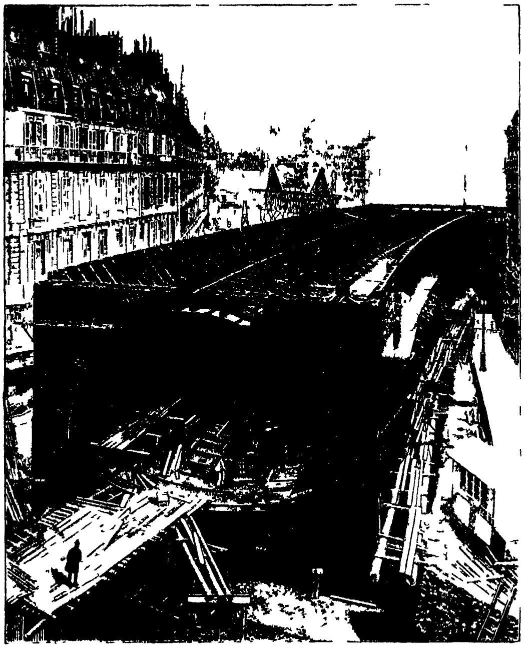
Beachy made the best time for one lap of 4 minutes [illegible] seconds.

The government dirigible was brought out and inflation attempted, but the gas leaked out faster than it went in, and after about $ 00 worth of gas had been expended the attempt was given up. It is claimed that the envelope received injury during the packing or unpacking.

There was an utter lack of interest in the ballooning events, both from the public and the balloonists themselves. As only two outside balloons were entered, the prizes were withdrawn.

The meet was a financial success, the daily attendance being enormous. There were several experiments made in throwing dummy bombs by Lincoln Beachy from his dirigible and Paulhan from his aeroplane, with Lieut. Paul Beck, U. S. A., as passenger. The low elevation at which these attempts were made, however, would seem to preclude the gaining of any valuable information.

Several local machines were tried out, but in each case the motor power was insufficient.



THE GREAT CENTRAL CAISSON OF THE PLACE SAINT MICHEL STATION.

PARIS AND ITS TUNNELS.

THE ERRANT EEL.*

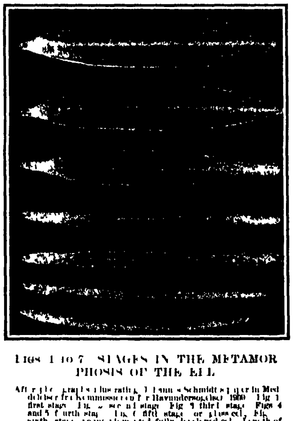
THE TRANSFOMATIONS AND MIGRATIONS OF A STRANGE FISH.

BY J. T. CUNNINGHAM, M.A., F.Z.S.

It is surprising to notice what a long time it takes for new discoveries about the most familiar things to become generally known and appreciated in spite of the facilities which now exist for the diffusion of knowledge. I have just read in the Daily Mail a letter to the editor informing the public that in the river Severn there is a tiny fish called the elver which is eaten with pepper, salt and vinegar and considered a great delicacy; that it is said by some to be a young lamprey, by others to be a distinct species, and that being very plentiful it is very cheap. It is not difficult to prove that elvers are young eels, and it has been known to naturalists for a long time that in the Severn and other rivers of Europe they ascend in countless multitudes in spring, apparently coming from the sea and traveling towards the upper and more inland fresh waters. From the bank they can be seen in dense swarms passing in continual procession, and the people of the neighborhood dip them out in baskets or hand nets to use them as food. As the slender threadlike wormlike creatures are able to wriggle their way up vertical surfaces and can live out of water a long time, it is easy to understand how not only in all streams and ditches but even isolated ponds and wells may become populated by eels. On the other hand no adult eels have ever been known to breed in fresh water. The earlier naturalists were unable to recognize the generative organs, and the male organs were first recognized by Syrski at Trieste in 1874. The males are smaller than the females, not exceeding a length of 19 inches, while the females may reach a length of 50 inches. The organs of the male examined by Syrski were not in the ripe condition, and with the exception of one male specimen neither males nor females have ever yet been seen with fully developed roes and milts. In the autumn in places where eels are plentiful the experience of fishermen has shown that there is an extensive migration down the rivers toward the sea, and this conclusion has recently been confirmed by marking specimens in Sweden. Only one or two very rare cases are known of eels taken in fresh water in which the roes were advanced in development; two of these, taken in Lough Neagh in Ireland in January and September, 189 , are preserved in the Museum of the College of Surgeons. Considering the enormous numbers of specimens in which the roes are but little developed, it is evident that these individuals in a different condition are exceptional and afford no evidence of the spawning taking place in fresh water, although it is a fact that in eels taken in autumn during the downward migration the reproductive organs are somewhat larger than in others. Before the discoveries of recent years had been made then, it was held as a probable conclusion from the above facts that eels spawned in the sea and that when the young were sufficiently developed they entered the mouths of rivers and ascended as elvers or eelfare, while the parents never returned from the sea.

In the course of zoological investigation another clue originally supposed to have no connection with the eel has been found to lead ultimately to the solution of the eel mystery. As long ago as 1763 was discovered on the coast of Wales a fish four inches long with a small head and transparent curiously compressed or ribbon-shaped body, which was named Leptocephalus. Since that time other specimens have been taken on British shores which have all proved to belong to the same species, but in the Mediterranean and at the entrance of the ocean several other kinds of Leptocephalus were found and were described under different specific names. In 1861 it was first suggested by Prof. Carus of Leipsic that the Leptocephali were the young stages or larvæ of other fishes, but he did not connect them with the eel family. It was the American ichthyologist Gill who in 1864 first on purely anatomical grounds came to the conclusion that Leptocephali were the larvæ of eels, and in particular *Leptocephalus morrisii*, the one first discovered, the larva of the Conger. Dr. Günther confirmed Gill's statements concerning the structural agreement, but maintained that the Leptocephali were not normal types of development but larvæ which had been arrested in their development and continued to grow, the reason being that fully developed young conger are often smaller than the Leptocephali. Similar views have been put forward in reference to other larval forms, but have in all cases proved to be erroneous, the reduction in size during metamorphosis having been found to be quite a common occurrence. In the case of the conger the question was set at rest by the actual observation of the transformation of a living Leptocephalus into a young conger; this observation was carried out by M. Yves Delage at Roscoff in Normandy in the year 1886, and the transformation was effected between April 18th and the beginning of July.

The next important step in the progress of these investigations was the identification among the numerous forms of Leptocephalus which had been distinguished, of the larvæ of the common eel. This was effected by Grassi and Calandruccio at Catania and Messina on the coast of Sicily in the years 1891-2. It has long been known that Leptocephali are more frequently seen and captured on the coasts of the Straits of Messina than anywhere else, a fact which seems to be due to the proximity of deep water and the currents and whirlpools for which the Straits are noted. Grassi and Calandruccio traced in aquaria the metamorphosis of several kinds of Leptocephalus into different species of the eel family or Murænidæ, and although they were not able to follow the whole process in the case of the common eel they satisfied themselves that the larva of this species was a form previously known as *Leptocephalus brevirostris*. This particular form had only been found in the Straits of Messina. It is rather small, not exceeding 8 centimeters (3¼ inches) in length and 1 centimeter in height. The fully transformed young eel was never less than 5 centimeters or 2 inches in length. Besides the larvæ the Italian naturalists obtained specimens of the adult eels with reproductive organs advanced in development, and found that these were distinguished from the ordinary specimens taken in fresh water by larger eyes and by a silvery color. They concluded from this increase in the size of the eyes and from taking eels and deep-sea fishes together that the eels spawn at depths of not less than 200 fathoms. The present writer, commenting on this at the time, pointed out that if it were true for the Atlantic coasts of Europe it would involve a migration of the adults from, say, the mouth of the Elbe to the Atlantic off the west of Ireland or the Bay of Biscay, and of the young the same enormous distance back again, a journey of about 800 miles each way, while in Sicily such depths occur within a mile or two of the coast. It seemed probable, therefore, that on the west coast of Europe the spawning of the eel might take place at more moderate depths. The recent extraordinary discoveries of the Danish naturalists, however, have proved that eels are actually hatched beyond the 500 fathom line to the west of Ireland or in the Bay of Biscay, and that an eel which may have spent the greater part of its life in the upper part of the Thames or in the Norfolk Broads becomes, when it is sexually mature, a deep-sea fish.



FIGS. 1 TO 7.—STAGES IN THE METAMORPHOSIS OF THE EEL.

After photographs illustrating Johannes Schmidt's paper in Meddelelser fra Kommissionen for Havundersøgelser, 1909. Fig. 1, first stage; Fig. 2, second stage; Fig. 3, third stage; Figs. 4 and 5, fourth stage; Fig. 6, fifth stage or glass eel; Fig. 7, sixth stage, young pigmented fully developed eel. Length of specimen shown in Fig. 1, 7.5 cm. (3 in.); of that shown in Fig. 7, 6.0 cm. (2⅜ in.).

The discovery of the Leptocephali of the eel in the Atlantic by the Danish investigators, in particular by Johannes Schmidt, by whom the actual work was carried out, was not due to accident, but to systematic and reasoned investigation. In the year 1904 the Danish steamer "Thor" was employed in collecting the young stages of edible fishes in the neighborhood of the Faroes and Iceland, which belong to Denmark. This work was undertaken in connection with the International Fisheries Investigations which have been going on since 1903. The eel being of great importance to the Danish fisheries, Mr. Schmidt was naturally anxious to obtain specimens of its larva, but although he used large small-meshed nets both at the bottom and at various depths he obtained only a single specimen of *Leptocephalus brevirostris*, which was taken in May, 1904, near the surface to the west of the Faroes at a position where the depth was about 600 fathoms. If the young eels which reach the coast in April or earlier were the offspring of adults which migrated to the sea in the preceding autumn, it would follow that Leptocephali would only occur in the winter months, but the Italian investigations showed that they occurred throughout the summer. It might also be that the larvæ were not free swimming but buried themselves in the sea bottom, but the fact of the single specimen being taken near the surface made this improbable, and it was concluded that the larvæ must be sought in more southern latitudes. Accordingly in 1905 from May to the end of June the "Thor" made a voyage from the north southward along the west of Scotland and Ireland, following the 500 fathom line, and Leptocephali were taken in increasing numbers till positions were reached off the entrance to the English Channel, where they were found to be most abundant, as many as 80 being taken in a two hours' haul. Farther south again, above similar depths in the Bay of Biscay, few were taken. The larvæ were found to be most abundant at a depth of about 0 fathoms from the surface, but were nearer the surface at night than in the daytime. These results proved that the greatest number of eels spawned in the deep ocean off the mouth of the English Channel, and indicate that the adults in their migration from the coasts bordering the North Sea pass chiefly through the channel to reach the ocean.

In September a few specimens were taken to the west of St. Kilda, and these were found to be in process of metamorphosis. The young eels, after the transformation is complete, are still quite transparent, and they make their way to the coast and enter the rivers. The ascent takes place earlier in places nearer to the Atlantic, and also the young eels in such places are more numerous; thus we have the explanation of the elver fishery in the Severn and other rivers entering the Bristol Channel. Similar ascents and similar fisheries occur on the Atlantic coast of France, becoming earlier as we pass from north to south, while on the other hand, in more northern countries, as Holland and Denmark, the ascent is later, taking place chiefly in April, May, and June. In 1906 the "Thor" made another voyage along the borders of the Atlantic basin to the west of Europe and found the Leptocephali in considerable numbers farther to the south in the Bay of Biscay, but here, as the sea bottom slopes more rapidly, they were captured at a shorter distance from the coast; this was especially the case along the north coast of Spain, where the 500 fathom line is quite close to the coast. In August and September larger numbers of more advanced specimens were obtained, and it was proved that these occur somewhat nearer to the coast than the earlier stages.

The occurrence of eel larvæ has naturally not been so completely followed in the winter months, but the fact that perfectly transparent cylindrical forms occur in the sea a little earlier than the time at which the elvers ascend rivers has been fully established. In the channel off Cape Grisnez Prof. Gilson at the beginning of February captured from 100 to 200 at a single haul, and in March and April they have been taken in numbers in the Skager Rack north of Denmark. From the large number of specimens which have been captured by Schmidt it is easy to trace the course of the metamorphosis, the essential points of which were already known from the work of Grassi and Calandruccio. In Figs. 1 to 7 are shown the successive stages. These figures are copied from Schmidt's photographs which were taken from the actual speci-

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* Knowledge and Scientific News.

mens after preservation in formalin, each specimen is of the average size of the stage it represents, so that the reduction in length and height which takes place during metamorphosis is correctly shown in proportion to the size of the figures. The average length of the first stage shown in Fig. 1 is 7.5 centimeters or 3 inches, the average length of the fully developed young eel taken in fresh water, represented in Fig. 7, is 6.6 centimeters or 2⅝ inches, the total reduction in length is therefore very nearly 1 centimeter, or 2/5 of an inch. The figures show that no reduction in length takes place until the curious change in the form of the body, in other words the reduction in height, has been very nearly completed. With regard to the actual changes of structure and form which take place in the metamorphosis it will be seen from the first figure, which represents the highest development of the Leptocephalus form, that in this the lateral muscles of the body, consisting as in all fishes of a series of muscle segments or myomeres, are much flattened and extended dorso-ventrally. The anus is far back, the intestine extending along the ventral edge through two-thirds of the length of the body. The vertical fin extends round the posterior third of the body from the anus round the tail to a point on the dorsal edge a little in advance of the anus. Fig. 2, representing the second stage, shows that the first change consists chiefly in the shortening of the intestine and the corresponding extension of the vertical fin; the changes in this direction are only slightly increased in subsequent stages, the dorsal fin especially extending a little farther forward in the final stage. Figs. 3, 4 and 5 show how the reduction in vertical height of the body takes place, proceeding from the head and tail to the middle. Fig. 6 shows the transparent young eel, which is still pelagic and has been taken swimming freely, especially at night, near the surface of the sea. One of the most extraordinary facts about this metamorphosis is that the larvæ take no food whatever during the course of it, a period of eight or nine months. In the fifth or glass-eel stage food has been occasionally found in the intestine, and some of these young may feed on their way to the more distant coasts, but the fact that the perfect pigmented stage represented in Fig. 7 is smaller than the transparent stage shows that no growth has taken place, but a continued reduction. Schmidt made a comparison between the average weight of the Leptocephali in stage 1 and of the glass eels in stage [illegible] and found that, during the transformation, the Leptocephalus lost over 77 per cent of its weight. It might be that this was merely a loss of water and was due to the consolidation of the tissues, but comparison of the weights of the dried specimens showed that the loss of dry weight was over 32 per cent, so that although the reduction in size is partly due to contraction of the tissues, there is also an actual consumption of material as the necessary result of so long a period of fasting. The actual weight is indicated by the following figures: On the average 601 Leptocephali in stage 1 weigh a kilogramme, while it takes 112 glass eels in stage 5 to make the same weight, or in English weight a little over 2 pounds.

THE STRUCTURE OF THE VOWEL SOUNDS.

HOW WE SPEAK.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

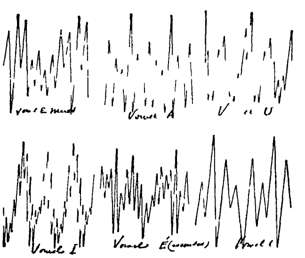
M. Devaux-Charbonnel, who occupies a prominent position in the Postal and Telegraph Department of Paris, recently carried out a series of researches upon the structure of the human voice. Different scientists have worked in this field. Helmholtz used a series of resonators before which he pronounced the vowels. Hermann used phonographic impressions and magnified them so as to form the sound waves. Koenig experimented with manometric flames.

The present work was developed by M. Devaux-Charbonnel by means of a telephone transmitter combined with an oscillograph, and the record of the waves obtained in the latter instrument were examined. It is to be noted that the study of the vowel sounds is the most important for understanding the structure of speech, as they play the principal part in spoken language, and it will be observed that the consonants serve only to modify the beginning or end of a vowel in order to form a complete syllable. The vowel sound has the longest duration, and therefore the researches bear especially upon these sounds.

The telephone is found to reproduce the voice, at least for short distances, with great exactness, hence it can be used to advantage. As we now have the oscillograph for registering vibration effect even of a short length, by combining the telephone with the oscillograph we can register the waves of the voice upon the photographic plate. In the method of mounting the apparatus the Blondel oscillograph is used. A moving mirror vibrates under the action of the telephonic currents, and this causes the wave form of such currents to be thrown upon a screen. Owing to the nature of the curves it was to be supposed that they were made up of a series of vibrations such as a fundamental note and its harmonics, and this in fact proved to be the case. M. Devaux-Charbonnel succeeded in decomposing the complex wave which was obtained for each of the vowels into series of waves, and these are found to be a fundamental note and a series of harmonics, varying according to the nature of each vowel. In order to carry this out he took photographic plates for each vowel sound and enlarged these by projection so that he could obtain curves of 20 inches height. The structure of the vowel waves was thus easily seen. In order to decompose the vowel wave into its harmonics, he proceeds by a method of elimination.

Thus the real structure of a vowel sound is readily observed, and he finds some interesting points in this way. The fundamental note is seen to be of a less intensity than the various harmonics. Taking the case of the vowel A, where the fundamental note is represented as unity, the second harmonic has a value of 1.7, the fourth harmonic 3.0 and the sixth harmonic 4.8. Here the sixth and the fourth harmonics are predominant, while the fundamental and the remaining harmonic are much less prominent. For the vowel O, the fifth harmonic predominates and has about four times the value of the fundamental note. For the vowel I, the second harmonic has about four times the value of the fundamental, and the 13th harmonic has nearly three times the value. It is natural that the vowel I should contain sharper sounds, that is higher harmonics than the vowels A or O, and this is seen to be the case here.

Another interesting point which is observed is that according to the above analysis of the waves, each of the vowel sounds generally contains a note which is more prominent than the others of the series. The vowel is therefore characterized by this note. Taking the fundamental note to be 160 vibrations per second, such as was observed in the present case for each of the vowels pronounced by a male voice, the most prominent wave in the vowel O is the fifth harmonic, and as above noted this is four times as strong as the fundamental. As the latter has 160 vibrations per second, the fifth harmonic will have five times this number or 800 vibrations per second. The note which corresponds to this number of vibrations is therefore prominent in the vowel O. In like manner the vowel A is characterized by a note which corresponds to 960 vibrations per second. For the vowel I the second harmonic, corresponding to 320 vibrations, is the strongest, but very near this value lies the thirteenth harmonic, which gives a note of 2,080 vibrations per second. It is the presence of this high note which gives the sharper sound which we observe in the vowel I, while the vowels A and O do not contain a note which is nearly as high as this, as might be expected from their lower or graver sounds.



THE STRUCTURE OF VOWEL SOUNDS.

These are the vowels of the French language: A as in palm; É (accented) as in met; E (mute) as in water; I as in feel; O as in [illegible]; U nearly equivalent to the German Ü.

The values for the characteristic notes of each vowel are nearly in concordance with what were obtained by Helmholtz, Koénig and the other experimentors mentioned above. This is due to the fact that in general the range of the male voice as regards speech lies at about the same value, this being near 160 vibrations per second. It must not be supposed, however, that each of the vowels has a certain pitch or fixed note which characterizes it, as might be supposed where the form of the wave could not be clearly observed. By the preceding examples it seems to be evident that the characteristic note is not separate and distinct, but is a harmonic of the fundamental note in each case. What is therefore striking in the researches seems to be the fact that each of the vowels contains a fundamental note of about 160 vibrations per second, together with various harmonics whose presence and value change with the different vowels, and that some of the harmonics may be much stronger than the fundamental note, so that they appear to make up the greater part of the vowel sound for each particular case.

In the above experiments the vowel sound was given before the telephone in a continuous manner, and this in fact somewhat resembles a musical sound, as it has a regular form. However, in ordinary conversation the vowel sounds are not pronounced in this way, but are combined with the consonants. It was therefore desired to find the effect of spoken syllables. To register these, a moving film was substituted for the fixed photographic plate. The film rolled upon a cylinder placed at one end of the opening, so that a flat portion could be moved across the path of the waves for a certain time, say one second, and we can now register the waves for several syllables. By pronouncing a series of vowels in succession, A O I E, for instance, we find that each vowel is composed in its main part of the waves which we observed above, but there is also an initial and a final period for each vowel, in which the sound increases or again diminishes. This period contains four or five vibrations.

As to the effect of consonants upon the waves, the presence of the former (which give an irregular trace) modifies the wave of the vowels during four or five periods. Each of the consonants has a different effect upon the vowel wave, but the vowel is generally not modified for more than the above mentioned amount. It is found that speech is thus not an exactly regular periodic phenomenon, but it is composed of regular (or wave) periods which are placed between quite different phenomena which are caused by the passage from one vowel to another, but these irregular periods are of comparatively short duration. It is observed that not more than 5 or 6 syllables per second can be clearly emitted by the voice, and above 10 syllables per second the words are no longer intelligible. For an ordinary male voice whose fundamental note corresponds to 160 vibrations per second, a single syllable will take in about 30 vibrations or periods. Of this number there will be more than 20 which correspond to the vowel sounds alone, and which show a very regular character. For the ear this part is the most prominent one of the phenomenon.

To sum up, we conclude that the human voice is to be recognized as a sound rather than a noise, that is, that the voice is formed of a succession of vibratory phenomena whose greater part is of a regular vibratory character.

The above considerations relate to the general theory of speech, but M. Devaux-Charbonnel considers that they will throw light also upon the question of telephonic currents, and he expects to make further researches upon their use in the field of telephone work in connection with instruments and telephone lines.

The United Railways and Electric Company of Baltimore, Md., has put into use a system of oiling the motor bearings of all revenue cars on a mileage basis. Motors are oiled at the division car houses on instructions from the office of the superintendent of shops, where all records of mileage are computed. Mail, express, maintenance of way and special parlor cars are not included in the plan, nor are snow plows and sweepers. The system is not intended to supplant the previous practice of having car house foremen follow closely the mileage of the cars in their charge, but it is believed it will relieve those divisions where the work of computing the mileage daily has proved too great a task and will result in better economy and efficiency of lubrication on the whole system.

THE WORLD'S SUGAR SUPPLY.*

SUGAR CANE AND BEET.

BY GEORGE T. SURFACE, PH.D.

The problem of sweetening humanity physically is only second to that of sweetening it temperamentally and morally. What was an efficacious medicine prior to the tenth century became through the increased quantity and the cultivated taste a delicate luxury from the tenth to the sixteenth century and thereafter began to be a staple food in certain parts of the world. In medieval times the peasants could only partake of sugar occasionally at special feasts and the privilege was so coveted as to make the sugar eating days loom up as bright spots on the mental horizon to lighten the burden of grinding poverty and everyday toil. The sixteenth century ushered in a new epoch of industrial development in which sugar was destined to play the most conspicuous part during at least a century. The islands of the West Indies and the tropical coasts of the Americas seemed to be but waiting for the transplanting of the cane and the introduction of the negro. The sugar industry and the slave traffic fitted into each other so perfectly that throughout the colonial exploitation of slavery the sugar industry was without a peer in the international trade. As late as 1850 more than half of the world's sugar crop was produced by slave labor and with the emancipation of slavery the tropical sugar industry suffered a depression from which it did not rise until it rose to find a dangerous competitor in the sugar beet of the temperate zone.

The sugar production of the world continues to increase more rapidly each year and yet the demand is economically greater than the supply. During the past quarter century the world's production has been doubled. In 1888 the total production of all countries was 6½ million tons and in 1908 the production was more than 14 million tons. In this interval the per capita consumption in the United States rose from 50 pounds to 83 pounds an increase of [illegible] per cent. The only country exceeding the United States in the great sugar eating contest is Great Britain whose record last year was almost [illegible]0 pounds for each man, woman and child. The enormous consumption of sugar in these two countries presents the anomaly of comparatively small producers being the largest consumers. It must be remembered however that the taste for sugar is far more natural than acquired and intensifies itself with the ability to pay the price. Denmark and Switzerland are the only other countries of Europe consuming as much as [illegible]0 pounds per head and the general average for all Europe is about 24 pounds per head. Germany the greatest sugar producing country consumes only 12 pound per head and Belgium the little industrial plant of the continent consumes only [illegible]4.4 pounds per head which is 15 per cent less than the German consumption. The variation in the amount of sugar consumed in the same country and in different countries finds its explanation in the cost of the commodity, the wages of the consumer and the native foodstuffs. The retail price of sugar in Naples and Milan is [illegible] cents per pound which is almost three times the London price but the average wage of the unskilled laborer in Italy is but one third to one half that of the corresponding English laborer. In addition the greatest poverty in Italy exists in the south where the food must consist largely of subtropical fruits and vegetables in which sugar is an important constituent. We need not therefore be surprised at the fact that the average sugar consumption in Italy is 8.3 pounds per year purchased at a cost of $1.12 or four days labor while the more fortunate Englishman purchases with the same amount of labor [illegible] pounds of sugar. The Austrians consumed only [illegible] pounds per year but the retail price is 7 to 8 cents per pound and the average wage less than one third that of the Englishman and one quarter that of the American.

Poverty makes necessary the purchase of the cheapest foods to the end of supplying a sustaining quantity and as starch foods are cheaper than sugar throughout the world the poorest classes in all countries show their preference for them. It is a fortunate coincidence that a large consumption of starch foods makes a corresponding consumption of sugar unnecessary since starch and sugar belong to the same chemical family. It is obvious that all classes with a sufficient income to purchase a diversity of foods consume more than the per capita average and that the wealthiest are the largest consumers.

The phenomenal increase in the demand for sugar is in part attributable to a gradual change in the opinion of medical and scientific students concerning its relative value as a food. When the medical profession was based upon one and two years of indifferent investigation the idea generally prevailed that sugar was a dangerous indigestible compound and the specific cause of many fatal organic diseases. To those who could not afford to purchase it this was the most convenient excuse for a minimum consumption and in many rural communities is as strenuously advocated today as it was fifty years ago when the cost of sugar was more than double. In the light of modern physiological and pathological research it seems conclusive that the dangers from an excessive use of sugar differ but little from those attending an excessive use of proteids or fats and that sugar is as essential to a well balanced ration as any other class of nutrients. In the production of heat and energy the proteid or nitrogenous foods and sugar are of about equal value and it is claimed by some experts that the nitrogen retention from proteid foods is increased at least 25 per cent if consumed with sugar. The horror of succumbing to kidney or liver diseases if sweets are indulged in is passing as a result of which many and perhaps all are indulging in those sweets more freely. In the wisdom of moderation an excess is to be avoided since it must result in indigestion which in its various forms is the mother of most of the ills of humanity.

SUGAR CANE ERA

Cane was without a successful rival in the production of commercial sugar until the middle of the nineteenth century when Germany and France began a vigorous and persistent development of the beet sugar industry. Limited quantities of maple sugar were manufactured in America and Europe and date sugar was a popular sweet in China but neither had an appreciable effect on the sugar market. That the beet sugar industry as late as 1825 was still in its experimental stage is evidenced by the fact that in that year the total production in France and Germany was less than 1000 tons. England imported in this year 200 000 tons of cane sugar from the West Indies and 10 000 tons from the East Indies which represented about one half of the total world production.

In the seventeenth and eighteenth centuries the Dutch East Indies (Java etc.), Spanish West Indies (Cuba, Porto Rico etc.), British West Indies (Barbados, Hayti etc.), Canary and Madeira Islands (under Spanish and Portuguese) and Brazil (under the Dutch) became the great cane growing regions for the European and American sugar supply.

The cane growing countries in the order of production in 1908 are: British India 2 016 000 tons, Java 1 156 000 tons, Cuba 961 958 tons, Hawaiian Islands 46[illegible] 288 tons, United States 50 000 tons, Porto Rico 200 000 tons, Queensland 188 000 tons, Brazil 180 000 tons, Mauritius 150 000 tons, Philippines 135 000 tons and all other countries 1 000 000 tons.

On the basis of value 93 per cent of the sugar imported into the United States is cane sugar. The total cane sugar imports last year were valued at $125 800 000 distributed as follows: Cuba $58 000 000, Hawaiian Islands $40 000 000, Porto Rico $19 000 000, Dutch East Indies $11 000 000 and the Philippine Islands $699 000. This means that excepting British India and China where the crop is consumed locally the United States consumes 60 per cent of the world's cane sugar crop.

THE FUTURE OF CANE

In the light of present development the future of the cane sugar industry is somewhat problematical. The beet sugar industry is increasing more rapidly than the rate of consumption and the competitive conditions in the cane growing countries are becoming more difficult each year. Twenty years ago cane sugar constituted two-thirds (66.2 per cent) of the total world supply while now it constitutes one half and yet in that period the total production was doubled. The cost of producing raw sugar is increasing in the leading cane growing countries and the cost of producing beet sugar is diminishing through improvements in seed selection, cultivation and machinery. It costs more than 2 cents to produce a pound of cane sugar in Cuba and a little less than 2 cents to produce a pound of beet sugar in Germany. But Austria and Holland are making beet sugar at even a less cost than Germany. The cost of production in the United States is from 2½ cents to 3 cents per pound which would indicate that the survival of the domestic industry has a vital dependence on the equalizing effect of import duties.

The present cane production in the United States is about equivalent to the annual average during the past 15 years which is convincing evidence that but little pressure would be required to bring about a decline in the cane sugar industry in this country. Not only is the cost of labor increasing in the Gulf States, but the profits from trucking, fruit growing, cotton and rice are increasing with the urgency of the demand.

THE RISE OF THE SUGAR BEET

The economic production of sugar from sugar beets has solved successfully the problem of meeting the growing demand for this popular and valuable food. The nations of the temperate zone are the great sugar consumers of the earth and the sugar beet is strictly a temperate zone plant. Like many other profitable industries it developed slowly in its early stages but is now progressing at a rate which is truly alarming to the countries whose chief source of revenue has been the cane sugar industry. The phenomenal increase in production is due to the growing demand for sugar, the profits realized by the grower and the manufacturer, the wide climatic and soil adaptation of the crop and the steady increase in the amount of sugar contained in the beet. In 1885 the beet crop of France had 7.83 per cent sugar and the German crop averaged 12 per cent as compared with 12.6 per cent in France and 17.5 per cent in Germany in 1908. With this record it is not surprising to find that Germany increased her beet acreage from 600 000 acres in 1885 to more than 1 000 000 acres in 1908 and her sugar output from 850 000 tons in 1885 to 2 223 000 tons in 1908.

IMPORTANT BEET GROWING COUNTRIES

Beets have been successfully grown for the manufacture of sugar in all of the continental countries of Europe and in the United States and Canada. The latitude zone may be said to extend from 45 deg to 58 deg according to the general climatic conditions. Most of the beet producing countries have a mean annual temperature of 55 deg to 65 deg F. The Department of Agriculture has defined the economic beet zone for the United States as a belt 100 miles in width on either side of the June, July and August isothermal line of 70 deg F. The moisture supply is of paramount importance with temperature and since it is almost impossible to obtain a distribution of rainfall ideally adapted to the crop the most satisfactory results are realized under irrigation.

Europe had last year 4 860 000 acres in beets which produced 7 041 000 tons (2 204 pounds) of sugar. Of this enormous sugar crop Germany had 2 221 521 tons more than one million tons of which were exported. The largest producing provinces in Germany are Saxony, Brandenburg, East Prussia and West Prussia. Saxony has long taken the lead with Magdeburg as the great manufacturing and refining center but the present tendency is toward the shifting of the center to Prussia.

Austria Hungary is the second largest beet grower with 816 000 acres and a sugar production of 1 409 000 tons. There are 119 sugar factories in Bohemia, 61 in Moravia and Silesia and 24 in Hungary. Sixty per cent of the total crop is exported to the various sugar importing countries of Europe.

Russia ranks first in acreage (1 386 996) and third in production (1 403 300 tons). These figures are a sufficient commentary on the inferior methods of cultivation in vogue. Russia has a continental climate which subjects the beet crop to great risks but no other country possesses so large an area on which beets of average sugar content can be matured. The domestic industry has had the effect of increasing the domestic consumption. In 1850 the consumption in Russia was about one half pound per head as compared with 17.6 pounds in 1908.

France, the most enthusiastic of European nations in the early development of the industry, is not keeping pace with the other important beet growing countries. Her production in 1908 was 719 900 tons manufactured by 255 factories. The French have made less progress than the Germans and the Austrians in the development of beets of high sugar content, the average in France being 12.6 per cent, in Austria 17.2 and in Germany 17.5.

Proportionate to area Belgium is the largest beet sugar producer in the world, one hundred and forty thousand acres producing 231 000 tons. On account of the size of the country and density of the population it is impossible to appropriate a much larger acreage to beets.

Holland cultivated 120 000 acres giving a production of 173 000 tons. The crop is manufactured by 28 plants many of which are also engaged in refining the raw sugar imported The cost of production in Holland is about 1 5 cents per pound, which is lower than in any other beet growing country The retail price is 9 4 cents per pound (Amsterdam) the result of the high consumption tax of 4 6 cents per pound

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*Yale Scientific Monthly.

Italy is the next largest producer in Europe having an output in 1908 of 150 223 tons Although limited areas are adapted to the cultivation the Italian production is being steadily increased Here the consumption tax is highest 5 7 cents per pound and the retail price highest 13½ cents (Naples and Milan) The poverty of the masses and the high price make a small consumption imperative 8 2 pounds per head

Sweden has expanded the industry to 109 500 tons which so nearly satisfies the domestic demand that the total sugar and molasses import in 1908 was only $16 654 The cultivation of the beet is concentrated in Scania with manufacturing centers at Helsingford and Kreflingo

There is a limited production in Spain Denmark Roumania Switzerland Bulgaria Greece and Servia

STATUS IN THE UNITED STATES

The first permanent beet sugar factory in the United States was constructed in 1870 at Alvarado Cal 32 years after the government made its first favorable report on the possibilities of the industry Unfortunately the first experiments were conducted in the humid States of the East which produced beets low in sugar The development was slow but steady following 1870 In 1892, we had only six factories in operation and a total production of 13,000 tons of sugar With the passage of the Dingley Bill of 1897 the industry was inspired with a new life resulting in the construction of fourteen new factories in 1899 The growth of the industry since 1897 is a record unparalleled by any other beet growing country having increased from 40 000 tons (1897) to 420 000 tons (1908) From 1890 1908 the cane sugar production in the United States increased scarcely 10 per cent while the beet sugar production increased from 2 223 tons to 420 000 tons The acreage has been more than doubled since 1901 and the production has been more than doubled since 1904 Sixty five factories are in operation in sixteen States Colorado and Michigan leading each with sixteen The important beet growing States in the order of production are Colorado California Michigan Utah Idaho Wisconsin Kansas Montana New York and Minnesota California Michigan Wisconsin and Idaho lead in crops of highest average sugar content

The total beet and cane sugar production in the United States supplies but one fifth of the domestic consumption On the estimate that our laboring constituents receive an average of 3 cents per pound in the production of home grown sugar $167 000 000 would be added to the pay roll if the production were equal to the consumption Can we anticipate such a development with hope? Why not? The Department of Agriculture estimates that the United States has 274 000 000 acres adapted by soil and climate to the cultivation of beets and that if this area were cultivated in four rotation crops beets constituting one the annual sugar production would be 15,000,000 tons The domestic demand would be supplied by the cultivation of 1 500 000 acres if the crop only averaged eight tons per acre The average price paid for beets in 1908 was $5 35 per ton as compared with $4 10 in 1897 The profits have been so satisfactory in the irrigated regions of the West that the price of land adapted to beets has increased since 1900 from 20 to 60 per cent more than the same grade farms not adapted to beets The factories have also flourished as evidenced by the construction of more than fifty from 1900 to date The total capital invested is conservatively estimated at $ 0 000 000

FLUCTUATION IN CONSUMPTION

The amount of sugar consumed varies with the financial situation and the price of the commodity From 1890 to 1900 the country experienced a general financial depression as a result of which sugar became a luxury to the poorer classes During this period the consumption increased from 1 pounds per head to 8 8 pounds an increase of 1 per cent From 1900 to 1907 is recognized as a period of unprecedented business prosperity and the sugar consumption increased from 58 8 pounds to 82 6 pounds an increase of 40 per cent In the interpretation of these statistics it should be remembered that from 1890 to 1900 the average price of refined sugar on the New York market was less than the average price from 1900 to 1907

A FORERUNNER OF COPERNICUS.

FORGOTTEN NICOLE ORESME.

BY PROF PIERRE DURHAM.

IN the year 1368 Albert von Helmstaedt better known by the name of Albert de Saxe a celebrated master of the Faculty of Arts of the University of Paris wrote a commentary on Aristotle s Treatise on the Heavens and the Earth One of the questions propounded in this treatise is whether the earth placed in the center of the universe is continually at rest or continually in motion In regard to this question Albert asserts that one of my masters appears to profess that it is impossible to demonstrate that the movement of the earth and the immobility of the heavens are incompatible with the observed phenomena Albert then proceeds with all respect to his master to demonstrate this incompatibility by the orthodox methods of the schoolmen The interesting point in all this is the evidence furnished of the existence in the middle of the fourteenth century of a professor of the University of Paris who regarded the rotation of the earth even as a possibility

Although this unnamed and unknown master did not convince Albert de Saxe he appears to have had better success with another student who attended lectures at the university about the same time This student was Nicole Oresme of Bayeux who came to Paris in 1348 to study theology and in 1356 became grand master of the College of Navarre In 1362 after having obtained the degree of master in theology he was appointed a canon of Rouen and two years later he was promoted to the rank of dean of the chapter He was created bishop of Lisieux in 1377 and died in that city in 1382

Oresme was endowed with remarkable mental activity and wrote a great number of works some in Latin and others in French in a style that made him one of the acknowledged masters of that language in the fourteenth century His treatise on money and coinage written both in Latin and in French exhibits him as a pioneer in the science of political economy and Curtze has shown that Oresme in a brief mathematical tract forestalled Descartes and Fermat in the invention of geometrical coordinates

The reigning king of France Charles V was desirous of disseminating among his subjects the knowledge that had been restricted to scholars acquainted with Latin In pursuance of this design the king appealed to the dean of Rouen to whom he had already given many tokens of his confidence and esteem

Oresme had already written in French a 'Treatise on the Sphere designed to teach the form and arrangement of the world, the number and order of the elements and the movements of the heavenly bodies to every man of free condition and noble mind ' The king now commissioned him to write French translations and commentaries on some of Aristotle's works In 1370-1 Oresme translated Aristotle's Ethics, Politics and Economics These translations and commentaries were printed in the 16th century Oresme also wrote a translation with extensive commentaries of Aristotle's Treatise on the Heavens and the Earth This work has never been printed but several manuscript copies are in existence One in the possession of the Bibliothèque Nationale is adorned with miniatures and bears the signature of the Duc de Berry brother of Charles V

In the second book of the Treatise on the Heavens and the Earth Aristotle proves to his own satisfaction that the earth remains motionless in the center of the universe After translating this section Oresme proceeds to give his own opinion subject to correction that the earth revolves daily on its axis and that the heavens are motionless He develops this opinion at great length and clearly and ingeniously shows the fallacy of the arguments urged against it—for example that the rotation of the earth would not account for the rising and setting of the sun moon and stars that it would necessarily produce a mighty east wind (the air being assumed to be left behind) and that a stone thrown vertically upward would strike the ground to the west of its point of departure Oresme takes the example of a ship moving very steadily eastward and shows that to an observer on board that ship a motionless vessel would appear to be moving westward and that it would be impossible for such an observer to decide which of the two vessels was moving He explains that the atmosphere moves with the earth as air confined in a closed vessel moves with the vessel and that a stone thrown vertically upward also moves with the earth both in ascending and in descending so that it necessarily returns to the point from which it was thrown Hence he concludes that it is impossible to prove by experiment that the heavens move and the earth remains at rest

After having thus shown the futility and fallacy of the appeal to experience Oresme proceeds to refute the religious metaphysical and astronomical arguments in favor of the immobility of the earth Here it becomes uninteresting and tedious to follow him The same remark applies to his support of his own opinion by positive arguments of which some are sound and ingenious and others metaphysical and absurd One argument is rather amusing Oresme says that if one thing receives benefit from another it should obtain this benefit by its own movement Hence the earth in order to receive the heat and light of the sun in all its parts must rotate on its axis instead of requiring the sun to revolve around it Thus the roasting joint turns on the spit before the fire but the fire does not move around the spit

Did Copernicus possess any knowledge of this dissertation in favor of the daily rotation of the earth? It appears impossible to give a decisive answer to this question Master Nicole Oresme's commentary on Aristotle s work written in French at the king s command and cost by one of the most important members of the University of Paris should have had a great vogue in France but the fact that it was written in French probably prevented its becoming widely known among foreign scholars It is a very remarkable fact that this one work has never been printed although the Treatise on the Sphere which was often appended to it in the manuscripts in accordance with the author s expressed desire was printed in the sixteenth century Hence it is very possible that Copernicus was ignorant of the existence of Oresme s work

On the other hand the arguments advanced by Copernicus in his treatise *De Revolutionibus Orbium Coelestium* in support of the possibility and probability of the daily rotation of the earth so strongly resemble Oresme s reasoning that this part of the great work of Copernicus might well be taken for a concise and somewhat obscure *résumé* of the corresponding portion of Oresme s commentary on Aristotle s Treatise on the Heavens and the Earth

At all events it is certain that the work of Nicholas Copernicus was anticipated even if it was not inspired by that of Nicholas Oresme Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Revue des Sciences Pures et Appliquées

AN AFRICAN ELEPHANT FARM

ONE of the great obstacles to agricultural development in the equatorial districts of Africa is the difficulty of procuring beasts of burden Horses have been tried in vain oxen soon become useless the ass would no doubt be a serviceable animal but it is difficult to acclimatize while zebras in spite of many attempts that have been made to break them in have never been domesticated to any serious extent In these circumstances some interest may be felt in an experiment which is being carried on by Commandant Laplume at Api in the Congo Free State and of which some particulars are given by M Daniel Bellet in Cosmos The African elephant has been generally considered as quite intractable but Commandant Laplume is of opinion that much may be done with him if caught young The catching takes place during the dry season A party is made up who set out to look for the fresh spoor of elephants They only follow those tracks which indicate that the herd contains calves of the right age to undergo training As soon as the herd is sighted guns are fired to frighten the animals and send the old ones flying The calf also runs or tries to run but its slowness permits the hunters to catch it up A rope is passed round its neck a second round its body behind the fore legs and then a third attached to the two others Three or four men walk in front holding one end of the last rope while the other end is held behind in the same way It is necessary to take the greatest care to prevent the animal being injured by the ropes in any way as even slight wounds are very dangerous to the calves and they are brought in to the farm as tenderly as possible The task of catching has been materially lightened of late because several of the elephants captured in former years have been trained to assist the hunters

In spite of all precautions however the losses are n id table. From January 4th to March 5th 1909 the commandant accompanied by 21 black hunters and 1[illegible] men captured [illegible] calves but 15 had to be released at once as they were not suitable and 7 died. Although the director of the farm has had great experience of this work the death rate among the calves is very high. They die of hæmaturia, dysentery, pining, and sunstroke, while some as soon as they are captured lie down and refuse to eat as though they were broken hearted.

The training at Api is conducted in this way. The driver begins by putting himself on good terms with the elephant, then he mounts her in the stable. He probably gets a few falls but apparently without any serious harm. The next step is to put on some simple harness by which two baskets may be carried on either side and these are filled with loads. After this a breast band is used and the elephant begins to draw a light tree trunk, then a little cart and finally a heavy wagon.

In the case of carts and wagons the animals are generally harnessed in pairs but for ploughing they are driven singly. They can get through a great amount of work. Recently the assistant manager of the farm took two elephants to fetch a wagon from a distance of 600 kilometers. They crossed the river Welle twice without any difficulty although it was from [illegible]0 to 100 meters wide. The elephants can also be used for riding, carrying the baggage as well as the rider; they travel at a rate of five kilometers an hour for about five hours but they ought not to be worked in the full heat of the sun. Doubtless the training and especially the capture of a herd costs a lot of time, trouble and money but the animals live to a good age and can work for many years. The farm at Api now owns some [illegible]0 trained elephants.

ENGINEERING NOTES.

According to a despatch to the daily press the electric station at Skabersjö, Sweden, has been operating for the past five years on gas made from peat. The despatch further states that the station has a fuel supply for 30 years in a bog of 37 acres in which the peat is five feet deep. Two 1[illegible]0 horse power generators are coupled direct to two gas engines which receive peat gas from two suction gas producers. The current is conducted about three miles to Svedala and used for street lighting and power for several small industries. The cost to consumers is about one half cent per horse power hour. Only tar is saved from the waste, but recent experiments indicate that in a somewhat larger station the sulphate of ammonia and other by-products may be made to pay all gas production expenses.

The Journal of Industrial and Engineering Chemistry contains the result of an important investigation by Messrs. Walker and Lewis of the causes of the corrosion of metal surfaces that have been painted or varnished. It has been found in practice that in tin cans which have been lacquered inside the corrosion under the influence of acid fruit juices has been much more rapid than in the case of untreated cans. This rapid corrosion takes place at points where the lacquer has been removed by soldering, etc., and is sometimes so pronounced as to cause puncturing of the can in a few weeks. The cause of this has been traced to the depolarizing action of the lacquer itself coupled with the action of the small proportion of air left in the can. The varnish coating being still unsaturated will absorb hydrogen. The protected surfaces will be thrown into the cathodic state and the solvent action of the fruit juices will be concentrated at the exposed places. The corrosion will then continue until the air has been consumed and the lacquer has become saturated. In the experiments upon which these conclusions were based two electrodes, one of ordinary iron and the other of lacquered iron, were inserted in the limbs of a V tube containing potassium chloride solution and provided with an air-free plug of agar agar at the bottom. When the electrodes were connected externally a strong reaction for iron was invariably obtained in the limb containing the plain iron, and tests made with Ostwald's bromide voltameter showed that the corrosion was the result of an electric current proceeding through the external circuit from the lacquered iron. To find a complete remedy for the trouble in the case of fruit cans it will be necessary to discover a lacquer impervious to the solution or failing that one that will not act as a hydrogen depolarizer. These results also have an important bearing upon the resistance of metals coated with paint to corrosive influences. The films of paint, etc., exposed to the air finally become completely saturated but this does not destroy their porous character or prevent the possibility of corrosion at any exposed points due to the depolarizing action of air through the film. This explains the pitting of iron or steel surfaces at places where the paint has peeled off and also shows the necessity of having the surface of the metal clean before the application of the paint. So long as the film is intact no corrosion of the metal takes place but the surface beneath the paint appears to become cathodic if an exposed area in its neighborhood can act as an anode. Under the influence of the cathodic liberation of hydrogen the film is gradually detached from the metal and corrosion of the exposed areas is greatly accelerated.

SCIENCE NOTES.

M. Paul Gaubert finds a new substance which is remarkable for its fluorescence. It is derived from physostigmine. Although the number of fluorescent bodies is considerable there are few in which the fluorescence is very strong and none of them can be compared with fluoresceine in this respect. It is therefore of interest to note that the present body has a fine red fluorescence which exceeds that of other known substances. The author observed it during researches he made upon the artificial coloration of crystals. The substance is obtained as follows: An aqueous solution of physostigmine is allowed to stand for several months until it takes a dark blue color. Then the addition of hydrated phthalic acid gives it a blood red color which is due to fluorescence. The production of this tint is a marked characteristic for both these bodies. The crystals of the new body are a dark blue, and other substances are colored by it in dark blue, such as silk, cotton, alcohol and ether, but these do not possess any fluorescence. On the contrary the water solution is remarkably fluorescent and even in the case of a drop of dilute solution which is a light bluish hue when we observe it by reflected light it has a deep red color comparable with that of the ruby.

It was shown some years ago by Mr. Otto Hehner and the present writer that the fat taken from different parts of the same animal varied both in its physical characteristics and chemical composition. Thus fat from the kidneys of a sheep was found to contain a large proportion of stearic acid whereas that from the neck of the animal was nearly fluid and quite free from stearic acid. The proportion of liquid fatty acids in the different fats was approximately measured by what is termed their iodine values, i. e., the percentage of iodine that they would absorb, and these figures showed equally great variations. The results of a similar investigation on the same lines have recently been published by Messrs. Moulton and Trowbridge, who have examined the fat from different parts of oxen. They find that there is an intimate connection between the amounts of fat and of moisture and protein in the fatty tissue of animals, a high proportion of fat being associated with a low proportion of moisture and protein and *vice versa*. The proportion of fat in the fatty tissue increases with the fatness of the animal and that of the moisture with the leanness, so that the condition and not the age is the determining factor. The percentage of fat in the fatty tissue increases from the outside to the inside of the animal while the moisture shows a decrease. The iodine value (indicating the percentage of liquid unsaturated fatty acids) increases with the age and with the fatness of the animal whereas the melting point of the fat decreases. A similar increase in the iodine value and decrease in the melting point may be observed on proceeding from the outside to the inside of the animal and there is a relationship between the two values, the one rising as the other falls. The specific gravity of the fat also varies with the iodine value.—Knowledge.

In a paper read before the Geological Society Dr. W. F. Hume, M.A., F.G.S., superintendent of the Geological Survey of Egypt, divides the fossiliferous cretaceous strata into three series: A northern Antonian type marked by Cenomanian species, including typical Turonian strata; a central Egyptian or Hammama type with a western chalky limestone indicating a close affinity with the white chalk of northern Europe. A southern or Dungul type having close affinities with the former and the fauna consisting of a group of specialized sea urchins and of gastropoda among which Turritellæ are very prominent. Dr. Hume emphasizes the uniformity of the Lower Eocene throughout Egypt, its triple subdivision being recognizable over vast areas. In the Middle Eocene this uniformity is replaced by differentiation, the well-known regions of the Fayûm and the Moqattam Hill differing from the succession in the area selected as typical in his paper. The Cretaceous and Eocene beds differ lithologically, limestones being dominant in the Lower Eocene and shales in the Upper Cretaceous. Palæontologically great groups such as the Ammonites still abundant in the Upper Cretaceous disappear in the Eocene and are replaced by the characteristic nummulinid foraminifera. On the other hand both periods bear a strong resemblance to each other in the dominance of oysters and sea urchins over other forms. A notable feature is the comparative rarity of brachiopoda in Egypt throughout both periods nor have belemnites been recorded from the Egyptian Cretaceous. Among post-Eocene formations the calcareous grits are shown to have a wide extension, but in the desert they differ in character from the mammal yielding beds of the Fayûm. The cretaceous period in Egypt was therefore one, in the main marked by the gain of sea over land, the Eocene was one of rest, while at the close of the Eocene and during the Oligocene the approach of a continental phase is clearly indicated.

TRADE NOTES AND FORMULÆ.

Siccative Powder is prepared by mixing 30 parts of lithopone, 30 of zinc white and 40 of manganese borate. Pass the whole through a fine sieve. This powder is a good drier for white paints.

Protective Paint for Ships' Bottoms.—For two coats (a) red lead [illegible]0 parts, white lead 30 parts, litharge 10 parts, oxide of zinc 20 parts, linseed oil 25 parts, oil of turpentine 25 parts. (b) Red lead 60 parts, oxide of zinc 30 parts, ocher 10 parts, chloride of mercury [illegible]0 parts, linseed oil 2[illegible] parts, oil of turpentine 25 parts.

To Blacken Iron and Steel.—Gently heat the article and apply a concentrated solution of copper nitrate or manganese nitrate in alcohol. By mixing the two solutions mentioned every desired shade of color between brown black and blue black may be obtained. Entirely satisfactory results can only be obtained with articles that have been thoroughly polished and cleaned with benzine.

Heavy Spar Siccative.—This is prepared in the same manner as ocher siccative. A beautiful bright red pigment will be obtained possessing excellent qualities as a coloring material. When mixed with linseed oil it will dry in 24 hours. If there is a choice between ocher and heavy spar it will be better to work with the latter as it dries better after precipitation, weighs more, coats better and has a really beautiful color.

Silver Balls.—Add 2 parts of yellow tripoli to 5 parts of levigated chalk, well mix the two powders and make them into a stiff paste with very weak mucilage (1 part gum arabic to 12 parts of water). The paste may then be rolled with the hand into balls about the size of a pigeon's egg. Place the balls on boards in a moderately hot room to dry and pack them when quite solid in tinfoil. Used for polishing silver.

Cement for Mother of Pearl.—Two parts of isinglass beaten into small pieces and soaked twenty-four hours in 16 parts of water, the mass to be then evaporated to half its volume, 8 parts of alcohol added and the mixture strained through linen. While the fluid is still hot stir in 1 part of mastic dissolved in 6 parts of alcohol and ½ part of sal ammoniac to make an even mixture. In use the surfaces to be cemented should be warmed before applying the cement. It will harden in five or six hours.

Soap Powder.—Soap powder is prepared from 40 parts calcined potash, 1[illegible] parts mountain flax (fibrous gypsum), 10 parts common soap and 10 parts water. Dissolve the soap in water, then add as much as the mass will take up of the mixture of potash and mountain flax. Then add the remaining parts of the potash and mountain flax to the mixture in a tub and place the powder in a drying room till thoroughly dry. Finally sift and pack the powder. It should be borne in mind when packing that the product readily attracts water, also that the packages are liable to burst if they are too full.

Safe Solder.—If equal parts of tin and lead are melted together and the crucible is allowed to cool slowly a time will arrive before the mixture entirely hardens when one part congeals to a granular pulp, while another part is still quite liquid. The latter can consequently be poured off if the right moment is not allowed to slip. It is a definite chemical compound of 3[illegible] parts of lead and 63 parts of tin and may be used with advantage as a rapid solder on account of its special fluidity. It need hardly be mentioned, however, that the same mixture can be prepared by simply mixing the metals in the given proportions.

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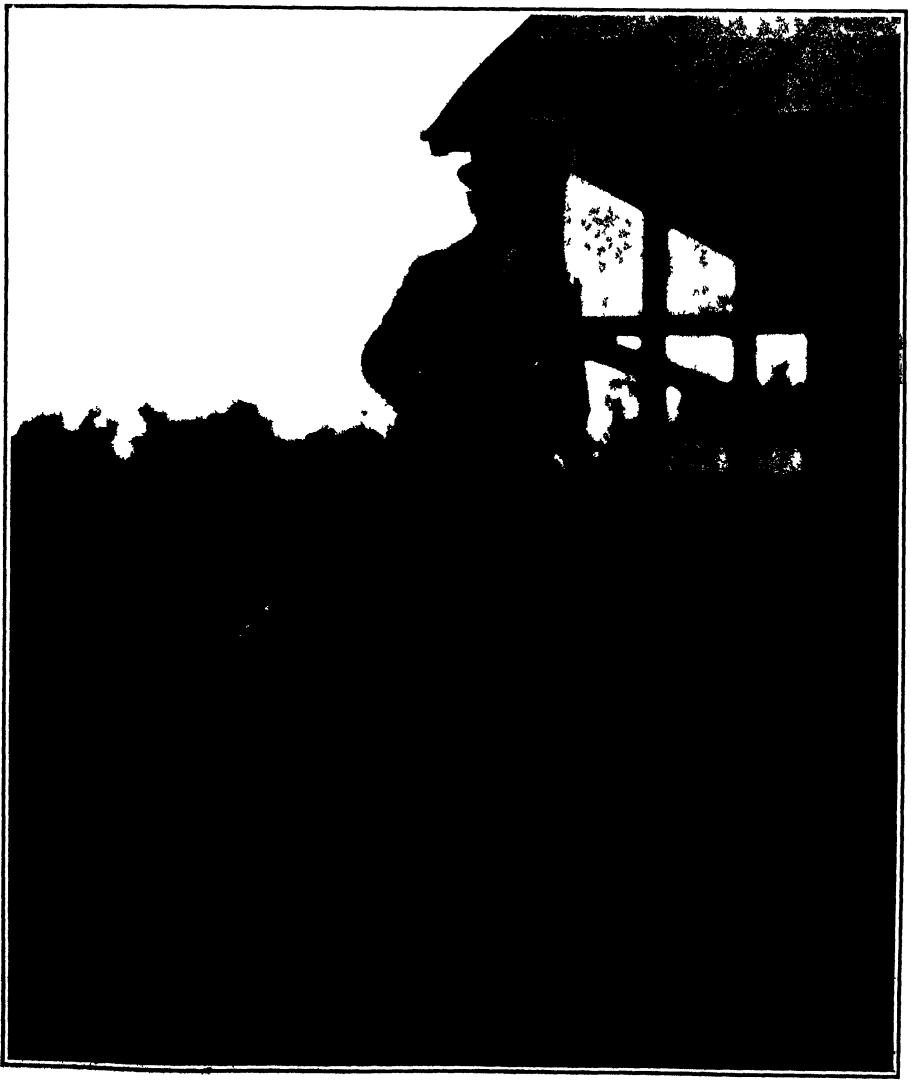


THE BIRD GIANTS

THE BIRD GIANTS.

OSTRICHES AND OSTRICH FARMS.

BY CHARLES FREDERICK HOLDER.

Among the big things which the State of California produces are ostriches. It has been found that the mild climate of southern California is remarkably well adapted for the purpose, and that ostriches breed and thrive as well here as in their native African haunts. The experiment was first tried by an Englishman, Mr. Edwin Cawston, who in 188 bought fifty-two birds in South Africa. It was a hazardous experiment, as the big birds are extremely difficult and dangerous to handle, but forty-two were landed on American soil. From these pioneers the fine ostrich farm at Pasadena, Cal., has grown, which at present contains two hundred birds. Here one can study the history of these birds from the egg to the adult, and as the industry is now protected by an import duty of 20 per cent the ostrich farm is on a sure financial basis and has become one of the paying American industries.

The Pasadena ostrich farm is beautifully situated among a grove of live oaks on the Arroyo Seco between the cities of Pasadena and Los Angeles. The inclosure of several acres is divided into corrals in which the various classes of birds are seen. As we enter the birds approach in droves with a queer mincing gait, ludicrous in the extreme. The ostrich impresses one as being the type of stupidity posing as a very wise personage, its large body, small head and brain constructed on economical principles, its enormous eyes, all carrying out the idea.

The birds are fearless and approach visitors, taking food from their hands. The correct thing to do seems to be to feed oranges, which are devoured whole, the diversion being mutual, as the orange presents a remarkable appearance as it passes down the long neck of the bird. The keeper, who tells us that he was once nearly killed by a bird, is a fund of information, and from him we learn all the secrets of running an ostrich farm. First one must have the birds, which cost from one thousand dollars upward apiece in Africa, but as they breed when they are three years old there is a quick return.

There is a definite arrangement in the corrals. The best feathered are selected and paired, space being left between the males, which fight and often kill one another. During the laying time it is often dangerous to approach them, the males rushing to the attack, and by a forward downward kick producing a serious wound, often fatal. Horses and even men have been killed, and when the charge is made the keepers find safety by lying flat on the ground.

The adult birds are magnificent creatures, standing seven feet high and weighing two hundred and fifty pounds. One of the interesting sights is to see them feed. They literally eat anything, according to the keeper, but are maintained on alfalfa. Among the extraordinary things that have been snatched from the hands of visitors and others and swallowed are nails, a gimlet, lighted pipes, a rolled newspaper. The writer once saw an ostrich snatch a bonnet from a lady's head and swallow it, but in this case a green veil that was the bonne bouche caused the animal's death. With their food of alfalfa and vegetables the birds are provided with broken shell for the lime, and quantities of pebbles, which they swallow to aid in grinding the food.

The breeding season, at which time we are fortunate in making our visit, is in early spring. The male bird now becomes very active and ugly. He rests his breast bone on the ground at some selected spot, and with his powerful claws throws the dirt away, turning round and round during the operation until a shallow hole is the result, by courtesy a nest. In this work the female sometimes joins. When it is complete the hen takes her place and lays an egg every other day. And what an egg it is! One would make an omelet for thirty men with moderate appetites, as one weighs three pounds and is equal to thirty hen's eggs. When twelve or fourteen eggs have been deposited the birds scatter a little sand over them and begin the labor of hatching them, dividing their time with almost mathematical precision, and presenting a remarkable instance of the sense of responsibility in both male and female. *The male takes his place at four o'clock in* the afternoon and covers the eggs. At nine o'clock in the morning he is relieved with all the promptness of a sentinel by the female, and it is an interesting point to notice that at noon, though the male is off duty, he relieves the female for an hour, allowing her to take a rest and obtain food. This can be seen by everyone, as the nests are in the open corral, and nesting carried on for nearly six weeks.

If one could approach the eggs now in the absence of both birds, a curious tapping would be heard on the shells, called "telephoning" by the keeper. In a word, the chicks have arrived and are knocking for admission into the world. Some succeed in breaking out, others have to be assisted, and the hen will press gently upon them at such times and break the shell, then she will take the youngster in her bill and pick it out, shaking the bits of shell from it.

The baby birds are most attractive little creatures, covered with very hairlike feathers and possessed of the greatest curiosity. They are at once taken from the parents and brought up by hand in nurseries especially arranged for baby ostriches. They are turned into a field of alfalfa during the day and at night kept in warm boxes or artificial mothers. For two or three days they do not seem to care to eat. Then they *eat stones and bone crushed, and on the fifth day al*falfa, from now on growing rapidly, so that at the age of six months they are six feet high, having grown at a rate of a foot a month; after this the growth is slower.

The reason for taking the young from the mother is a purely business one, as the birds immediately build another nest, which they would not do if the young were left with them to rear, so instead of one brood a year the owner obtains seventy or eighty eggs from a single bird. In six weeks the chicks are tall and robust birds, beautifully spotted and rapidly becoming valuable commodities. At a year old they are valued at $1 0 a pair, chicks three to six weeks old $40 a pair, while the full grown bird is valued at $300 per pair. It is evident then that the ostrich is within the reach of the average individual, yet there are some drawbacks, as an ordinary ostrich has an appetite that apparently has no limitations, and one will literally eat a poor man out of house and home.

The birds are valued for their feathers, for which there is a growing demand, and if the visitor is present at the farm during what is termed the "picking" he or she is well repaid. The full feathered bird is a beautiful creature, but every feather is not valuable or a plume. The feathers are of many kinds and differ widely. In the very young birds they are yellow and white, later dark drab on the male, black and white in the female. The fine plumes are found on the adult male, and to bring the best price should be taken from the living bird, those from the wing being the most esteemed, especially the so-called ivory colored plumes.

The picking of the feather crop occurs every few months, the occasion being not only interesting but exciting, as the birds protest decidedly to the robbery. The pickers are men skilled in the business, necessarily so, as poor picking ruins feathers and birds. When picked the feathers are what is termed ripe, that is they would soon be thrown off by the moulting process, consequently there is little or no pain in the operation. The heavy plumes are cut off, the stumps being removed three months later.

At this picking time the birds are separated and driven into a narrow pen, their heads being covered with a perforated bag. The men station themselves behind, so that the bird cannot kick, and holding it securely the picking is performed in view of the large audience that usually collects at this time. Three *crops of feathers are obtained in about two years*, each bird being estimated to produce $30 per year in feathers, and as each bird attains an age of from fifty to even seventy years the profit of feathers alone is enormous, not to count the young. As the feathers are collected they are classified and placed in bags, those of the males in one, those of the females in another, as all have some peculiar market value, and the grades are well recognized by the trade.

When graded and weighed they go to the expert feather dressers of Los Angeles, San Francisco and New York. Here they are tied on strings four feet in length, or in bunches, classified thoroughly, and are then sent to the dyer, as no matter whether the feather is naturally black it is dyed black. After this they are washed in water and starch, the latter is then removed when they are ready for the finisher, where they are graded, assorted, sewed together, often three or five pieces to make one plume, they are then steamed to allow the fibers to take their natural position. The curler now takes them and gives the plume the graceful shape so desired. From the hands of the curler they pass to the man called the "buncher," who combs them out and gives them the particular shape demanded by fashion. Now the plume or feather is *ready for the market and is placed on sale*. The history of the feather from the hatching of the young ostrich to the beautiful plume on the hat of some lady is a long and complicated one.

The commercial side of the industry is not without interest. Birds are sold to circuses and shows, the unfertile eggs bring a dollar apiece as curiosities, the feathers are made into boas, which range from $3 to $35, capes ranging from $16 to $25, fans, tips, single plumes, collarettes, and other objects suggestive that ostrich farming must be a profitable business, indeed, in South Africa it was at one time ranked next to that of the diamond in point of value.

But the interest in the farm to the average visitor consists in the birds and their strange habits, whether bathing in the pool, or walking jauntily around the corral, or sailing along with outspread wings, they present a fascinating spectacle. The strength of the male ostrich has been the subject of many experiments at the Pasadena farm, and not the least interesting is the great bird used as a saddle horse, a boy mounting the steed and riding it about, the bird carrying its load with the greatest ease. The birds have also been harnessed and driven tandem, to the delight of the young people.

A visit to this farm corrects many errors that may have *found place in the mind of the observer*. The ostrich does not thrust its head in the sand to avoid its enemy, but boldly charges horse or man, though, sad to relate, a dog will demoralize the entire herd. This is because the ostrich knows that it cannot strike so small an animal. That the birds allow the sun to hatch their eggs is another fiction exploded by a visit to the ostrich farm. No hen displays greater solicitude than does this gigantic mother, who is constantly robbed of her chicks, never enjoys the pleasure of maternity, of leading her young about, but is kept nestling the year around. If allowed to care for her young the mother ostrich proves to be a famous caretaker. She, the giant mother of the bird creation, exercises them all day long, forcing them to run and eat, and at night gives them shelter beneath her warm plumes.

Sand Dunes in New Zealand.—Dr. Cockayne gives an interesting account of New Zealand sand dunes in an official report. The characteristic of a dune as contrasted with a fixed hill consists of its instability, due to the material of which it is composed, hence the facility with which the whole mass can be moved to a longer or shorter distance according to the velocity *of the wind*. Dunes are *most frequent* along the sea coast, but some are also present inland. Owing to the inland movement of the coastal dunes much valuable land has been lost, and the danger is yearly becoming more difficult to combat. The area now occupied by dunes is roughly speaking 290 000 acres in the North Island and 24 000 acres in the South Island. The dunes of western Wellington occupy an area of more than 90 000 acres and extend for about 170 miles along the coast.

The formation of the sand of the dunes commences on mountain sides, where the action of frost, variations in temperature, etc., bring about disintegration of rocks, such broken up material is transported by rivers to the sea, which it reaches in various degrees of fineness varying from boulders to fine sand. A certain amount of sand is also directly due to the erosive action of the sea. Sand grains of dunes are distinguished from ordinary river and sea sands in being thoroughly rounded due to the rolling backward and forward in a dry state by wind.

The dune flora is remarkably uniform throughout New Zealand, owing to the soil factor proving to be of more importance than the climatic factor. The dunes of the Auckland Islands have a special flora of their own. Dune plants proper not only tolerate but benefit by a partial sand burial, and are highly specialized, being characterized by their great length of stem. This enables them to spread over wide areas, and to increase rapidly by vegetative means under conditions which would be fatal to seedlings. Among the most important of such "sand binders" are *Spinifex hirsutus*, a grass; *Scirpus frondosus*, a sedge; and *Euphorbia glauca*, a spurge. A few other plants usually present are of minor importance. It is very rare indeed that a dune in course of formation is quite destitute of plant life, indeed, the majority owe their progress and existence to the presence of 'sand binding' plants, which in the first instance have stopped the sand drift and assist further deposits to collect, while at the same time their own growth is accelerated, they and the sand rising up together. It is remarkable how scanty a plant covering checks the wind, even where tufts of grass or sedge are only a foot tall and where more than two-thirds of the surface is unprotected it is remarkably stable.

The author considers that judging from the results obtained in Europe the great bulk of the sand dunes in New Zealand could be reclaimed. The final treatment of dunes should be afforestation.—Knowledge.

MENDEL AND THE ORIGIN OF SPECIES.

A NEW BIOLOGICAL LAW.

BY PROF. OTTO N. WITT.

It is a well known fact that children whose parents differ greatly from each other exhibit the characteristics of both parents. Often, as in the case of domestic animals, this mixture of characters is so apparent that even inexperienced observers easily distinguish mongrels from animals of pure breed. The idea suggests itself that frequently repeated crosses must result in a form in which so many different characters are combined that it cannot be referred to any known type, but constitutes a new species which can be kept constant in the future by preventing further crossing.

Some valuable breeds of animals have undoubtedly been produced substantially in this way. In general, however, no crossbreeding exerts such a decisive influence upon natural selection and the origin of species. This is the more remarkable because there is apparently, nothing to prevent the crossing of wild animals, and crosses between widely separated plants are promoted by natural agencies for the transport of pollen and natural obstacles to self fertilization. As a matter of fact the production of natural hybrids is an exceedingly common occurrence in the vegetable kingdom. It might be supposed that in these favorable conditions for crossbreeding all clearly distinguishable species must have vanished long ago. This is assuredly not the case, for though the idea of species is a creation of the human mind it is based upon observed facts and it cannot be denied that despite all variations certain specific characters are transmitted unchanged.

To explain this paradox it has been suggested that hybrids are less prolific than pure species and consequently soon disappear. This hypothesis is based chiefly on the sterility of the mule, the hybrid between the horse and the ass. But there are many hybrids which reproduce their kind indefinitely and especially in plants crossing may occur between very dissimilar types, though the progeny sometimes appears exactly like one parent and exhibits none of the special characters of the other.

Hence the permanence of hybrids cannot be explained by the absolute or comparative sterility of hybrids. Another explanation is based on the often observed appearance of characters which are apparently inherited not from the immediate parents but from remote ancestors, as if the organism were striving to revert to its original type. Darwin observed this phenomenon, which he called atavism, but did not discover the laws that govern it. Much more was accomplished in this direction by the Austrian monk Mendel, whose researches were long neglected and have only recently received due appreciation.

Mendel's celebrated experiments in hybridizing peas are very ingenious and interesting, although they do not, in my opinion, possess the far reaching importance which many biologists accord to them. They have the advantage over most experiments of the sort that they can be performed within a comparatively short period.

By crossing a red flowering with a white flowering variety Mendel obtained peas which, when sown, produced almost exclusively plants with pink blossoms which apparently represented a mixture of the floral colors of the two parents. But Mendel found it impossible to perpetuate the pink flowering variety by self fertilization, for each successive generation exhibited an increased proportion of reversions to the two original types, red flowering and white flowering, into which the pink variety was finally almost completely resolved.

Similar experiments, yielding similar results, have since been performed with other plants and with animals. The great diversity of colors exhibited by many flowers is known to result from the combination of a very few pigments. Attempts have been made to establish quantitative laws for the combination and the subsequent separation of these pigments. A new doctrine, Mendelism, has arisen and has already produced a literature the copiousness of which suggests that it would be better for a while to make more observations and fewer deductions.

This biological phenomenon (like many others, as I have recently shown) bears a striking resemblance to that in phenomena of molecular physics. In a great number of instances two chemical compounds when mixed together produce a substance which exhibits the properties of both ingredients and which can be resolved again into those ingredients by appropriate treatment (for example, crystallization or fractional distillation). But here also the resolution is not effected at once, but successive intermediate products containing continually increasing proportions of one or the other original constituent are formed and the complete separation is accomplished only after many repetitions of the process in which the tendency to separate is manifested. As the characters, chiefly colors, to which the observations of the Mendelists are confined at present are determined by the presence of definite chemical compounds (pigments) in the tissues it is evident that a causal connection and not merely a chance resemblance exists between the chemical transformations described above and the changes in the colors of flowers and animals which are studied by the Mendelists.

Whether a complete knowledge of the nature of hybridization can be obtained from the observation of such changes in color is another question and one which I regard as very doubtful. A pea vine or a variegated dog possesses a good many characters which are not necessarily connected. It is not even claimed that all of these characters appear or vanish together and we are justified in expecting that they will not do so.

An example will make my meaning clearer. We will assume that peas, the favorite subjects of experiment, belong (which they do not) to a family of plants of which some members are very poisonous and others are harmless. Let us suppose that white flowering peas are harmless and red flowering peas are poisonous. If the color is a certain indication of all other characters the pink flowering hybrid peas will be somewhat poisonous and their continued propagation will result in the production of very poisonous red flowering peas and perfectly harmless white flowering peas. In these conditions, however, I would not have sufficient confidence in the infallibility of the Mendelian theory to eat abundantly of the white flowering peas thus regenerated from the poisonous pink flowering variety.

Mendelian experiments are not only so protracted that in many cases several generations of men would be required to complete them, but they also have the defect that the observation must be restricted to single characters because it is scarcely possible to take cognizance of the entire process. From these observations of single characters many biologists draw conclusions of unwarranted generality.

Here again an example will make my meaning clear, and I will take the example from our own species, where it is most evident that a single character cannot serve as a guide to the rest. We will assume that a brother and sister, each having light hair, a phlegmatic disposition and special talent for mathematics, marry a sister and brother who have red hair, quick tempers and great musical gifts. We will grant to the children of both marriages all these characters in various proportions, but can we imagine that if these children intermarry and their descendants intermarry for many generations the last generation will consist exclusively of blond, phlegmatic mathematicians and of musicians of fiery hair and temper? Does not experience lead us to expect at least a few blond musicians and red haired but phlegmatic persons?

Many experiments in crossbreeding fail to yield results in accordance with Mendel's laws. Albinism, or the absence of the normal pigmentation, is very common in both animals and plants. The offspring of two parents both of which are albinos might be expected to inherit this striking peculiarity, but this is not always the case. Albinism is very common among orchids and pure white orchids are especially prized and diligently sought. But while the progeny of some albino orchids resembles their parents, the seedlings of others bear without exception deeply colored flowers. Possibly a tendency to albinism would ultimately appear in the descendants of these colored hybrids of white orchids, but who has time to carry on a Mendelian experiment in which eight years are required for the maturing of each generation?

Hybridization unquestionably plays some part in the production of new species, but this part is neither so important as superficial observation often suggests, nor so insignificant as it is made to appear by unwarranted generalization of Mendel's observations. The origin of species is a very complex phenomenon dependent on the cooperation of many causes and we shall wait long for its complete explanation.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

HOW THE BODY PROTECTS ITSELF AGAINST MICRO-ORGANISMS.

How is it, if the air contains floating in it the dried spores of multitudinous micro-organisms which only need a suitable medium for their development and increase, how is it that they do not obtain a lodgment in the healthy animal body, which one would think offers all the conditions necessary to their growth? It can easily be shown that the air we breathe, the water we drink, the food we eat, everything that we touch swarms with these microscopic creatures, that they enter our lungs, that they germinate in our skin, that they occur in countless numbers in our alimentary canals, in short, that they are found everywhere on our body surfaces. How is it that they do not increase and turn our organs into a seething mass of putrefying corruption? One would expect that even if the skin and the membrane bounding the internal organs to which they obtain entrance incurred the slightest lesion, even a pin prick, that they would have been able to enter. We know that after death they at once obtain complete dominion and we therefore infer that in life there must be some protective mechanism in the body capable of dealing with them.

The discovery that there is such a mechanism was made in the early eighties by the distinguished Russian zoologist Elias Metschnikoff, though the need of its existence was not recognised by biologists in general until later. The result of this was that his remarkable discoveries were at first pooh-poohed and discredited by many, but ultimately they gained acceptance and their further development in his own hand and that of others has wrought a revolution in the art of preventive medicine.

The mechanism consists of the small amœboid cells found in the blood, lymph and body fluids generally, and called leucocytes or white blood corpuscles. Though long known to exist, very little had been ascertained as to their function until Metschnikoff, working at such remote subjects as the embryology of sponges, the structure and digestion of polyps, the blood of water fleas, realized that these small amœba-like cells which exist in all organisms actually swallow, digest and so destroy small foreign bodies which have invaded the organisms. He called them the phagocytes, and all his subsequent work has been directed to the elucidation of their mode of action.

It is to Metschnikoff's work, prompted solely by the scientific spirit, that we owe our knowledge of phagocytosis and the great theory of immunity which has proceeded from it. It is impossible at the present moment to estimate fully the value to man of Metschnikoff's discoveries. Suffice it to say that they have already led to important practical results.

Application was recently made for protection of an invention to produce ammonia from the atmosphere by means of aluminium. Nothing is yet known of the details of the process, but from the titles of the three applications it is gathered, says the Chemical Trades Journal, that the aluminium and nitrogen are first caused to combine to form nitrides of aluminium which afterward are converted into ammonia.

AN INTERNAL-COMBUSTION PUMP.—I.*

APPLICATIONS OF A NEW PRINCIPLE.

BY HERBERT A. HUMPHREY

Pumps play such an important part in every branch of engineering that no apology is needed in bringing before the notice of this Institution a construction of pump based upon entirely new principles. Every engineer is familiar with pumps driven mechanically or by steam, and recently there has been considerable development of pumps driven by gas engines. The South Staffordshire Mines Drainage Commissioners, for instance, have replaced steam engines by gas engines in five of their pumping stations with very beneficial results, the change having led to a considerable economy of working.

Compound condensing direct-driven steam pumps of modern construction and large size are among the most economical of all steam-using plants, and under favorable conditions will give a pump horse-power hour for an expenditure of 18 pounds of steam. But at the other end of the scale we have the direct-acting steam pump, generally working with very little or no expansion. Such pumps are notoriously uneconomical and frequently use 100 pounds to 150 pounds of steam per pump horse-power hour. It is only the extreme convenience and simplicity of such pumps that induces engineers to tolerate their low efficiency.

Fig 1 DIAGRAM OF THE FIRST EXPERIMENTAL FOUR CYCLE PUMP.

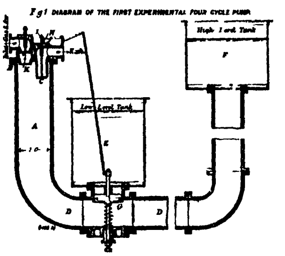


Fig 2. COMPRESSION PRESSURE DUE TO A LIFT EQUAL TO 50 LBS PER SQ IN

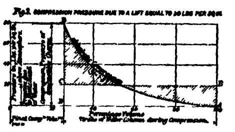
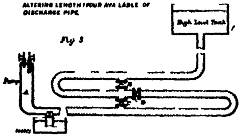


DIAGRAM ILLUSTRATING METHOD OF ALTERING PERIODICITY BY ALTERING LENGTH (FOUR AVAILABLE) OF DISCHARGE PIPE.



IGNITION APPARATUS FOR FIRING AT MAXIMUM COMPRESSION PRESSURE

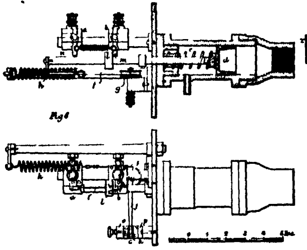
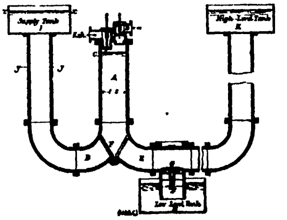


Fig 5. DIAGRAM OF TWO-CYCLE PUMP



Economy of fuel is undoubtedly obtained when an internal-combustion engine is used to generate the power for driving a pump, but by the time the mechanical efficiency of the gas engine and the intermediate gearing is taken into account, one finds that the economy is considerably discounted, and such a combination of gas engine and pump can never be regarded as a final solution of the problem.

The author's aim has been to produce a pump of great simplicity and strength of construction, in which the explosive force is exerted directly upon the water, and in which no rotating flywheel, solid piston, connecting rod, crank, bearings, or glands of any sort are required; and as the results of his experiments several very successful types of pumps have been invented and set to work on a sufficiently large scale to demonstrate their utility and economy.

The idea of exploding a combustible mixture of gas and air to produce pressure on the surface of water with the object of raising the water is, of course, not new, and attempts to put this idea into practice date back to 1848. The efforts have all been directed too much along the lines of ordinary pumps, insofar that the water lifted has always been forced past a non-return valve, and the operation of such a valve with the explosive force behind it has been inevitably disastrous. In the types of pumps invented by the author there is, when the explosion occurs, a full-bore passage from the combustion chamber to the final outlet; also some of the water pumped to a high level by the energy of the explosion is allowed to return again to compress a fresh combustible charge. When sudden changes of velocity occur in masses of a heavy and incompressible liquid like water, great difficulty is found in controlling the movement of the liquid. All such difficulties are removed in the author's pumps by allowing the movements of liquid to control the pump, and by causing the mass of liquid moved to be sufficiently large so that the velocities are never excessive. The mass of water forms a pendulum which swings between the high and lower level, and by its movement alone serves to draw in fresh water, to exhaust the burnt products, to draw in a fresh combustible charge, and to compress the charge previous to ignition. With the movements of the liquid quite unrestrained by any of the usual mechanical appliances, the result is a pump which works with freedom from shock and noise, and which requires very few working parts.

The subject attains a wider scientific interest from the fact that the apparatus follows a cycle in which the expansion of the burnt products is carried to atmospheric pressure, and so involves a thermodynamic cycle of greater efficiency than can be claimed for the Otto cycle. The underlying principles of the invention are capable of application in many useful directions besides that of raising or forcing liquids, and are especially adaptable to the compression of elastic fluids.

The researches and experimental work, which have occupied three years, constitute an attack upon the gas pump, gas turbine, and gas engine problems, and these three have been so closely associated in the author's mind that it is almost impossible to treat the gas pump as a thing apart. It seems natural and proper, therefore, to present the general scientific aspect of the problem first.

Every text book which deals with the theory of the gas engine contrasts the theoretically perfect indicator diagram with diagrams obtained in actual practice. There is no gas engine on the market working on a cycle which permits expansion of the ignited gases to be carried beyond the original suction volume. As a consequence, when a gas engine is working at full load the exhaust gases are rejected at a high temperature and at a pressure of between two and three atmospheres. The energy thus wasted is a considerable percentage of the total energy converted into work, and we must put this waste down as an inherent defect in all existing types of gas engines. The requirements for a perfect cycle are as follows:

1. The suction stroke taking in the combustible mixture.
2. The compression stroke, the length of which is dependent upon the compression pressure desired.
3. The working or expansion stroke, which should be much longer than (1) in order to fully utilize the work of the expanding gases.
4. The exhaust stroke, which is another long stroke comparable with (3), but the exact length of which depends upon the clearance space.

All four strokes will be of unequal length, and a perfect gas engine should be capable of meeting these conditions.

Again, theory indicates that for great economy we must have high temperatures, and in practice we know that at such temperatures it is impossible to lubricate the piston unless the cylinder walls are cooled. The larger the diameter of the cylinder the thicker must be the walls of the cylinder to resist the bursting pressure, and the more difficult it becomes to conduct away the heat fast enough. Experiments have shown that with the largest cylinders now in use, having a thickness of say 4 inches of metal, the limit is nearly reached, so that if cylinder walls be made much thicker the lubricating oil would be burnt up and pre-ignition trouble would arise, even with a good circulation of cold water on the outside of the cylinder. Perhaps the chief difficulties which designers of large gas engines have had to meet are those arising from expansion and contraction of the cylinder and piston, which have necessitated somewhat complicated arrangements for cooling, the latter by circulating through it high-pressure water, and the use of a large water jacket in connection with the former. Broken cylinder covers, jacket castings, and cracked pistons are not nearly so common now as they were, thanks to the great ingenuity and skill displayed in their design, but the necessity for meeting expansion at all points has not tended to simplicity in the modern gas engine. Some years ago the author carried out experiments with a Vogt gas engine, and the trials showed that internal cooling arising from the use of a water piston was consistent with a high thermal efficiency. It seems logical, therefore, to conclude that, at least in large units, the outside water jacket will be dispensed with and internal cooling substituted, and the ideal engine should possess this method of internal cooling.

Let us now for one moment consider the actual construction of the gas engine as it exists to-day. We find a solid piston with its water-cooling arrangements, its piston rings, its piston rod, and somewhat expensive type of gland packing, and the usual connecting rod, cross head, and guides, and then the crankshaft and flywheel with the massive bearings, lubricating devices, and strong framework. If we take the Otto engine as the simplest type of engine, and which often dispenses with the piston rod, we yet have the two-to-one gearing with the side shaft carrying the cams to operate the necessary levers and valves. How much of all this is really necessary? In answering this question a list of the actual essentials which a gas engine must possess may be made out as follows: A working cylinder, an inlet valve for combustible mixture, an exhaust valve for burnt products, a flywheel, and an ignition device.

Obviously the numerous things which belong to a gas engine outside of these essentials would readily be dispensed with if it were possible to do without them, and we should then arrive at a gas engine in which the energy was delivered direct to the flywheel without any intermediate gearing. To retain this degree of simplicity the flywheel would also have to fulfill the functions of a piston which draws in a fresh combustible charge and compresses it in the cylinder. If we imagine everything discarded which first principles do not demand as necessary, our ideal engine will have the following properties and parts:

1. It must be capable of four unequal strokes.
2. It must utilise the whole possible range of expansion down to atmospheric pressure.
3. The energy must be delivered direct to the flywheel without any intermediate parts.
4. There must be internal-cooling arrangements, so that the cylinders may be made of any size within the limits of structural possibility.

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* Paper read before the Institution of Mechanical Engineers.

5. There must be an ignition device, but, as there is no two-to-one shaft to operate it, it must be entirely automatic and depend only upon the compression pressure having reached a maximum

6 Difficulties connected with contraction and expansion must be eliminated

These conditions may look sufficiently impossible, but the ideal engine must not only fulfill them, but must be capable of meeting other requirements Thus, "it is surely not wise to take in a whole cylinderful of mixture when the output of the engine is only a fraction of its maximum, all the strokes should be shortened up when the call for power is less, assuming, of course that the number of strokes per minute are to remain constant, which is generally the case

Having evolved our conditions for an ideal engine from first principles only the question is How far can a practical machine be made to meet these conditions? So far as a prime mover on these lines is concerned the author believes that a practical solution can be found but the following considerations tempt him to depart from a direct solution

Granted that water is needed for internal cooling then surely it is better to use a water piston If this piston is made heavy enough it may well serve as a flywheel but it will be a reciprocating instead of a rotary flywheel Here then the temptation to extreme simplicity comes in Let us for the moment abandon the idea of a prime mover with a rotating shaft, and allow our water flywheel to so reciprocate that at each working stroke it leaves a quantity of water at a higher level or pressure This only requires the fitting of a single water valve but our final apparatus then becomes a pump instead of an engine, and our gas power appears as water power

The arguments and conclusions having been stated, we are in a position to proceed with a description of the apparatus employed by the author in carrying out the principles involved It should however be mentioned that the order in which the different types of apparatus are here described is chosen for logical sequence, but is not that in which they were actually invented

Fig 1, page 100, is a diagram of one of the simplest forms of construction It consists essentially of a combustion chamber *A* fitted with an inlet valve *B* for combustible mixture, and an exhaust valve *C* for burnt products A pipe *D* connects the bottom of the combustion chamber to a low level tank *E* and to a high-level tank *F*, and between this pipe and the former there is a water valve *G* The inlet valve *B* is normally kept shut by a spring, but the exhaust valve *C* has no spring to hold it up and falls by its own weight when pawl *H* is removed from under a collar *J* fastened on the exhaust-valve stem This pawl is operated from the water valve *G* in the simple manner shown, so that when the water valve opens it releases the exhaust valve. Suppose all the valves shut and a compressed combustible charge to exist in the top of the combustion chamber The rest of the chamber and the pipe are full of water Explosion occurs at a sparking plug *A* and the increase of pressure drives the water downward in the chamber and forces the column of water contained in the pipe to move toward the high level tank, so that a quantity of water is discharged into this tank From the moment when ignition occurs to the time when expansion reaches a pressure equivalent to the static head of the water in the high level tank the excess pressure in the combustion chamber has been increasing the velocity of flow toward the high level tank so that at the end of this period the column of water has a considerable velocity The kinetic energy thus acquired causes the water to continue to flow in the same direction until the pressure on the under side of the water valve is less than that above the water valve and the difference of pressure causes this valve to open

This occurs when the products of combustion have expanded to about atmospheric pressure The opening of the water valve releases the exhaust valve and now water from the low level tank flows past the water valve partly to follow the column of water still moving toward the high level tank and partly to flow into the combustion chamber to expel some of the exhaust gases There is of course a tendency for the water to rise in the chamber to the same level as the water in the low level tank but usually a little before this level is quite reached the kinetic energy of the moving column has been expended in forcing more water into the high level tank and the column has therefore come to rest At this point of the cycle the spring on the water valve quietly closes this valve and is assisted by the water now trying to flow back from the high level tank to the chamber It cannot flow back far because there is already a considerable quantity of water in the chamber and as the column rises further it reaches the exhaust valve and striking against it shuts it by impact The exhaust valve is immediately locked shut by the pawl shown engaging under the collar of the valve stem and now that there is no longer any outlet for the small quantity of burnt products which remain they are imprisoned in the top of the chamber and suffer compression as the water continues to rise until the energy thus stored in the compressed elastic cushion is equivalent to the energy given out by the falling water Thus the elastic cushion serves to bring the column of water again to rest and as the compression pressure considerably exceeds the static head of the water column a reverse flow is set up while this cushion expands again If there were no friction losses the water column would be forced back by the cushion to the same point as that from which it started—namely, to a level in the combustion chamber a little below the level of the water in the low level tank but it actually does not move quite so far However when the water passes the level of the exhaust valve the elastic cushion is again at atmospheric pressure and the further descent of the water in the combustion chamber tends to create a vacuum but the inlet valve is only held shut by a light spring and can therefore readily open to admit a fresh combustible charge during the rest of the descent and until the water column is once more at rest The state of affairs now reached is of course still unstable because of the unbalanced pressure due to the head in the high level tank and this head produces a second return of the column so that water ascends in the combustion chamber and compresses the fresh combustible charge The explosion of the charge by means of the ignition plug now starts a fresh cycle The operation of the apparatus is so simple that when an actual apparatus on these lines was first tried it ran steadily at the very first attempt

Although the apparatus just described looks so simple yet the calculations required in studying the complete working conditions are very complicated Up to the present the author has not been able to express the results of calculations in any general formula including all the variables involved Integration on a time base is the only method so far used to follow out the conditions through a complete cycle It is not therefore intended to deal fully with the theory of the pump but some general observations will be of service

Height of Lift In the first place it will be observed that the quantity of water delivered considerably exceeds what might be described as the stroke of the pump or the change in volume of the gases from the time they are ignited until they expand to atmosphere This is due to the water entrained from the low level tank to follow the moving column of liquid going to the high level tank Consequently if an indicator diagram could be obtained and the mean pressure of the stroke calculated such pressure must be in excess of the equivalent pressure due to the head against which the water is raised The burnt gases always expand down to atmosphere therefore their mean pressure is less than that obtained in an Otto cycle gas engine since the stroke is so much greater and as a result the head against which the water is lifted is limited to some 25 feet to 40 feet in most cases This limitation is however entirely overcome by one or other of several arrangements to be described later which enables water to be raised to practically any pressure which may be required

Length of Pipe.—The length of pipe between the combustion chamber and the high level tank must be sufficient to contain such a mass of water that its kinetic energy at maximum velocity shall insure the

Fig 6. DIAGRAM OF MODIFIED TWO-CYCLE PUMP

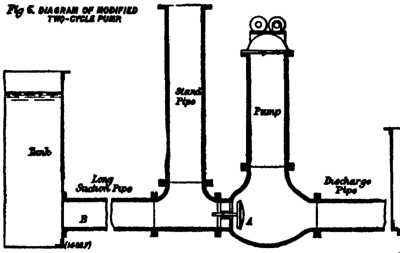


Fig 7. DIAGRAM OF DOUBLE BARREL TWO-CYCLE PUMP

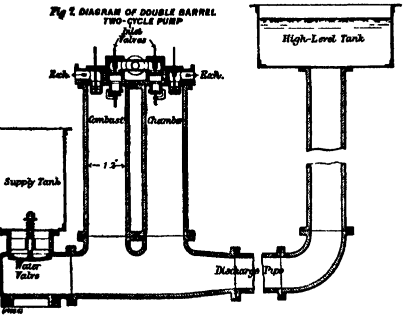


Fig 8 FIRST EXPERIMENTAL TWO-CYCLE PUMP. (1906)

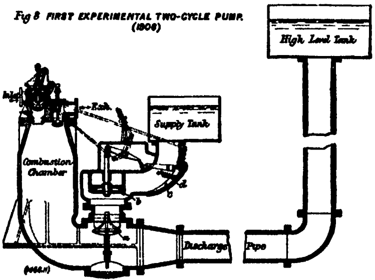


Fig 10 DIAGRAM OF A PUMP USED FOR DRIVING AN AIR-COMPRESSOR.

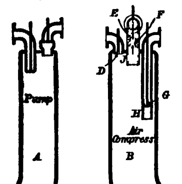
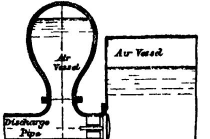


Fig 9 ADDITION AT END OF DISCHARGE PIPE WHEN HIGH LIFTS ARE REQUIRED



burnt gases being expanded to atmosphere. This is the limiting condition but the pump will work with any greater mass of water. If we fix 10 feet or 12 feet per second as the maximum velocity then the smallest quantity of reciprocating water can be calculated for a given set of conditions. Theoretically a comparatively short pipe of large diameter is better than a long pipe of smaller diameter for not only can larger quantities of water be pumped without exceeding the maximum velocity of flow but the time of a cycle is less with the short pipe. With a given difference of pressure between the two ends of the column the acceleration is the same per unit of cross section for all diameters of pipe of the same length and a given volume of ignited gases can therefore expand to atmosphere in a shorter time when the delivery main is of a larger diameter. In the pumps so far constructed the diameter of the delivery main has been made almost as large as the diameter of the combustion chamber if the latter is of cylindrical form. The periodicity of the cycle also depends on the length of the discharge pipe and lengthening the pipe reduces the number of cycles per minute. It is found in practice that as the head against the pump increases the minimum length of the discharge pipe must also be increased so as to allow time for the water from the suction tank to rise in the combustion chamber before the column in the discharge pipe returns.

Supply Tank. Since the volume of combustible mixture drawn into the combustion chamber is partly dependent upon the level of water in the supply tank any alteration in this level affects the working of the pump and affords one simple method of regulating the amount of energy developed at each cycle. Thus by raising the level of the water smaller charges are drawn in and conversely by lowering the level larger charges result. A float controlling the inlet to the supply tank may thus be used to regulate the output and power.

Compression Pressure. The thermal efficiency of any apparatus deriving its energy from the expansion of an ignited combustible mixture depends upon the pressure to which the mixture is compressed before ignition; therefore high compression pressures are desirable within certain limits. The fact that the column of liquid which returns to compress the fresh combustible charge in the pump attains velocity in so doing and then has its kinetic energy transformed into pressure energy is most useful in this respect for it enables compression pressures to be used greatly exceeding the static pressures due to the head of water which causes the return flow. Fig. 2 will serve to make this clear. If the ordinate *AB* represents the pressure due to the static head of water and if *AD* represents the distance through which the column of water moves while compressing the charge the work done is represented by the rectangle *ABCD*. An equivalent amount of work must be stored in the compressed gases but as their pressure was only that of the atmosphere at starting their final pressure will be at F so that the area *AFD* is equal to that of the rectangle and the two shaded areas are equal to one another.

As the compression pressure is raised the average pressure throughout the stroke is also raised which means that the pump can deliver water against a greater head but the greater head causes a greater compression pressure and hence the pump is largely self-regulating. Thus if called upon to pump against a greater head the compression pressure automatically rises and brings about conditions favorable for the increased work it has to do.

Cushion Space. The volume of the top of the combustion chamber above the level of the exhaust valve forms a clearance space comparable with the clearance space of an ordinary Otto cycle gas engine and the products of combustion which remain in this space are mixed off with the fresh combustible charge and thus dilute this charge. This fact limits the amount of the clearance space in its relation to the charge volume and if this proportion is kept at about the same as in gas engines—namely about 20 per cent—then it happens that as the head against which the water is delivered increases the maximum cushion pressure may rise above the explosion pressure. This is especially the case if a pump designed for using small charges is worked with large charges of combustible mixture since this is equivalent to reducing the clearance space ratio. Although an astonishing amount of elasticity in working condition is possible yet it is desirable to overcome any objection which may be raised on account of the high cushion pressure. This can be done in a very simple way by making the clearance space much greater than in an Otto cycle engine and using an effective scavenging device so that practically pure air exists in the clearance space and the combustible charge drawn in can then be richer in gas.

The clearance space being enlarged in this manner enables the requisite energy to be stored in the cushion at a lower maximum pressure.

Scavenging.—Positive scavenging arrangements when applied to gas engines involve the use of pumps of some kind and therefore add to the number of parts and to the complication of the apparatus. In the author's pump scavenging is a very simple matter as it is only necessary to insure that there is sufficient inertia in the water on the supply side to prevent this water flowing so quickly into the delivery pipe as to meet the full requirements of the moving column and the result is at once to cause the moving column to draw part of its water supply from the combustion chamber and thus lower the level therein. Then instead of exhaust products flowing outwardly past the exhaust valve when the exhaust first opens air will be drawn in past this valve and later when the water rises in the chamber to drive out the burnt products it will leave a mixture of air and products in the cushion space. This in fact is what happened in the first pump constructed for however close the supply tank may be to the delivery pipe there is enough inertia to produce the effect. If a long exhaust pipe is used to conduct away the burnt gases these gases alone would be drawn back and as it is not desirable to work without an exhaust pipe the scavenging effect can be turned to much better advantage by introducing a special scavenging valve and giving the combustion chamber a suitable shape and this has been done in later constructions.

Operation of the Valves.—All three valves being at liberty to move so soon as there is any difference of pressure to move them open and shut quietly unless the speed of working is allowed to become too great. The shutting of the exhaust valve by the impact of water upon it was not expected to take place with such absolute certainty and precision as is actually found and indeed the exhaust valve was not originally designed as a simple valve but when this simple form was tried it worked so well that its adoption now forms one of the features of the pump.

The suction which produces scavenging also tends to open the inlet valve Fig. 1 and draw in some combustible gases which might then be wasted by passing away in the exhaust. This can be prevented by tightening up the spring on the admission valve but this method involves frictional losses in drawing in the charge. This difficulty and also the necessity for some connection for operating the exhaust valve from the water valve is obviated by the introduction of a new design of valve gear which is described later and in pumps as now constructed the inlet and exhaust valves mutually control one another so that no connection with the water valves is wanted.

Starting, Stopping and Controlling. In first starting the pump all that is necessary is to allow a charge of compressed air to flow into the combustion chamber and so depress the water level a little below the usual charge volume. If the exhaust valve is now forcibly opened the water will rise in the chamber close the exhaust valve and give the cushion and charging strokes. The charge drawn in is then fired and the pump starts working. If the pump is at work and it is desired to stop it is only necessary to switch off the current which operates the sparking coil. The pump then stops with a charge of unexploded mixture in it and can at any time be started again by merely switching on the current. Such simple and instantaneous means of starting and stopping enable the pump to be controlled from a distance. In fact it can be operated from a switchboard at any convenient place.

The general methods of controlling a gas engine are applicable to the pump. Thus the inlet valve may be fitted with a throttle valve controlled by the pressure or height of the water and either the mixture or the gas alone may be governed according to the power to be developed. There is however something to be said for allowing the pump always to work at maximum capacity and then a float on the high level tank may serve to cut off the ignition and to switch it on again as the water rises and falls between two fixed levels. The methods of controlling the pump by altering its periodicity have already been referred to and it is easy to arrange that a portion of the delivery pipe shall be cut out or put into action so as to alter its effective length. This may be done by valves as shown diagrammatically in Fig. 3. Thus the longest pipe route between the chamber *A* and the high level tank will be when valves *B* and *C* are closed and valve *D* open and the shortest route will be when valves *B* and *C* are open and the valve *D* closed.

Ignition Apparatus. The author has invented an ignition apparatus in which ignition is determined by the compression pressure reaching the maximum incidental to each particular charge. It will be sufficient to describe one form of the apparatus which is shown in Fig. 4 (page 100) and is intended to work on the high tension system with the use of an induction coil. The low tension circuit supplying the coil is capable of being broken at three points by switches marked *a*, *b* and *c*. When all three switches are closed simultaneously sparking occurs. In the apparatus shown there is a piston *d* acted upon by the water in the chamber, so that the pressure which exists at any moment in the combustion chamber is transferred by means of a water connection to the apparatus, and acts upon the right hand side of piston *d* causing compression of the spring *e* and a movement of the piston rod to the left. The piston rod which projects outside the cylinder has attached to it one end of a band *f* which passes over a pulley *g* and has its other end attached to a spring *h* and in turn the pulley *g* carries a switch arm *j* which has its movement limited by two stops. When passing between these stops it rides over contact *k* and closes the circuit so far as this switch is concerned. On the piston rod is a collar *l* which at pressures below the desired range of compression pressures moves switch lever *m* and breaks the circuit at this point and at pressures above the range of compression pressures moves switch lever *n* and breaks the circuit at this other point.

The action of the apparatus is as follows. At atmospheric pressure switch arm *j* is against stop *p* switch *b* is open and switch *a* is closed. As the pressure rises switch arm *j* passes over the contact to stop *o* and on further increases of pressure switch *b* is closed by the action of its spring. This state of affairs continues until the compression pressure has attained its maximum and begins to decline slightly the band in the meantime slipping round pulley *g*. As soon however as a very small decrease in pressures takes place the friction of the band on the pulley causes the switch arm *j* to pass on to the contact *k* and the other two switches being closed sparking occurs. The charge is thus fired and the increase of pressure arising from the explosion causes the switch arm to pass to the stop *o* and also opens switch *a*. Expansion now takes place and the switch arm passes from stop *o* to stop *p* as the pressure diminishes and then switch *a* closes and *b* is opened so that we again arrive at atmospheric pressure with everything in readiness to start a fresh cycle. In the type of pump already described the cushion pressure gives rise to another maximum but this pressure being above the range of the compression pressures switch *a* is then open and the passage of the switch arm *j* over the contact *k* does not in this movement produce a spark. This ignition apparatus is applicable to all types of the author's pumps and entirely safeguards any chance of pre-ignition since ignition can only occur just after the compression pressure has attained its maximum. When the pump is to run at a steady load it is sometimes convenient to cut out the operation of the switch arm and to set switch *b* in such a position that it closes just at the right compression pressure or slightly before it is reached. In this case there is another spark produced on the cushion stroke but as there is then no mixture to fire it does no harm. The author has also invented an ignition apparatus which will produce a spark slightly before the maximum compression pressure whatever this maximum pressure may be but the apparatus just described has been found so satisfactory that it has been used throughout most of the experiments.

Two-Cycle Pumps.—The pump so far described is what may be called a four-cycle pump because there are two outward and two inward movements of the column of liquid in each complete cycle. It would clearly be advantageous to suppress the cushion stroke and the suction stroke and so produce a two-cycle pump. We are familiar with two-cycle gas engines in which outside pumps are used to draw in the gas and air and to force them into the working cylinder. But the production of a two-cycle pump is arrived at without any such complication since no outside pumps are required. Up to the present four types of two-cycle pumps have been constructed and of these the simplest to explain is that shown in Fig. 5 where *A* is the combustion chamber fitted with an inlet valve *B* for combustible mixture and exhaust valve *C* for burnt products. The bottom of the chamber is attached to a pipe having two branches *D* and *F* and a single valve F which can close communication with either of the branches. One branch leads to a supply tank containing water at a level *x x* the other branch leads to the delivery pipe and the high level tank and is fitted with a water valve *G* which in this case is shown as closing a suction pipe dipping into a low level tank *H*. When the valve *F* is in the position shown by full lines and the compressed combustible charge exists in the top of the chamber *A* explosion takes place, and water is driven along the delivery pipe toward the high level tank the gases meanwhile expanding and imparting velocity to the column of water. When expansion has been carried to atmospheric pressure the exhaust valve opens and by this time the pressure on the left hand side of the valve *F* will exceed the pressure on the right hand side, and the valve will swing across so as to open communication between the combustion chamber and tank *J* and to close communication with the delivery pipe. The moving column of water now has to entrain more water by sucking it up from tank *H* past valve *G* to follow the moving column. In the meantime the water level in the combustion chamber being considerably below the water level in tank J . water will rise up in the combustion chamber, close the exhaust valve by impact, and cushion the burnt products imprisoned in the top of the chamber above this valve, until their pressure exceeds that due to the static head of the liquid in tank J A reverse flow now occurs as the compressed cushion expands again, and a charge of combustible mixture is drawn into the combustion chamber If there is still time for the action to take place, there will be a slight compression of the fresh charge by water again flowing from tank J into the chamber but the main compression of the charge occurs when the column of water in the delivery pipe having come to rest returns, again closing valve G and forcing valve F from its dotted position back to the full line position thus giving free communication between the delivery pipe and the combustion chamber and closing communication with tank J When the water column has been brought to rest by expending its energy in compressing the charge, a spark at the ignition plug ignites the charge and a fresh cycle is started It is not necessary that the level of the water in tank J should be above the exhaust valve because if it is at a level y y the oscillation which takes place from the tank to the chamber may still carry it far enough up the combustion chamber to close the exhaust valve The return flow, which draws in the new charge will then be due to gravity as the liquid in the chamber tends to regain the level of the water in tank J It is desirable that a pump so constructed should have a dashpot to control the movements of valve F so that it comes slowly on to its seat in the dotted position and gives time for the water to be started in motion past valve G before communication with the combustion chamber is entirely cut off If this valve is also controlled in its action of closing on its other seat it may be arranged that the quantity of water which escapes past the valve back to tank I shall be equal to the quantity of water which moves from tank J to the chamber and in this case the whole of the water delivered is drawn from tank H and the returning column in the delivery pipe will then acquire a higher velocity than it would otherwise attain and thus give a higher compression pressure

A modification of this pump is shown in Fig 6 which simplifies the arrangement and permits the use of any one water valve In this case between the supply tank and the combustion chamber there is enough pipe to give a certain amount of inertia and on this pipe is a standpipe open at the top up and down which the water oscillates Suppose that explosion and expansion have occurred and water is being drawn past the valve A It is clear that the supply will be drawn from the source which offers least resistance so that the water contained in the standpipe will first flow past valve A to be followed by water from pipe B so soon as the greater inertia of this mass allows it to flow forward When however the water in the pipe B has once been set in motion its momentum keeps it moving although valve A may be shut so that it causes the level to rise in the standpipe even above the level of the water in the supply tank This brings about a condition of affairs in which when the water valve A again opens the level of the water in the standpipe is considerably above the level of water in the combustion chamber A quick rush of water therefore takes place and the oscillation carries the water up the combustion chamber to close the exhaust valve The necessary supply for this having come from the standpipe its level is lowered until it is below the exhaust valve and consequently gravity causes the level of water to fall in the combustion chamber and so draw in a fresh charge while the column of the water in the discharge pipe is still moving outwardly The return of the column from the discharge pipe closes valve A and compresses the new charge ready for a fresh cycle

Passing over a large number of modifications of the types of pumps so far dealt with we come to a pump having two chambers, in which the explosions take place alternately A diagram of this arrangement is shown in Fig 7 and one of its chief differences from the other pumps is found in the fact that the introduction of the combustible charge does not depend either on cushioning or on an oscillation of the kind described Both chambers are fitted with the usual inlet and exhaust valve, but a single water valve suffices to supply both chambers Suppose all the valves are shut, and that in the first chamber there exists a compressed combustible charge and that the second chamber is full of water Explosion occurs in the first chamber, and water is driven downward and outward from this chamber toward the high level tank As the gases expand a pressure is reached which can no longer sustain the water column in the second chamber, so that the water level in this chamber falls and a fresh charge is drawn into this chamber When expansion is completed, we have, therefore burnt products in the first chamber, a fresh charge in the second chamber, and water at a higher level in the supply tank than in either of the chambers Consequently water flows from the supply tank toward both chambers and partially clears the first chamber of burnt products by rising to nearly the level of the water in the tank Water has been entrained through the water valve to follow the column of water flowing toward the high level tank and as this column comes to rest and commences to return again it closes the valve and flows mostly into the first chamber from which the burnt products have a free exit past the exhaust valve As the water reaches the exhaust valve and shuts it it finds only a very small cushion space in the top of this chamber and its flow in this direction is therefore almost immediately arrested so that the energy of the returning column is now obliged to expend itself in compressing the combustible charge in the second chamber When this compression is complete and the water once more at rest the cycle is ready to be repeated by an explosion occurring in the second chamber It will be noticed that when compression occurred the returning column had already moved some distance while exhausting products from the first chamber and therefore it had an initial velocity when starting compression which causes the maximum pressure reached with this pump to exceed the compression pressures attained with the same head of water in the other types of pumps This pump is therefore suitable for low lifts where high compression pressures could not otherwise be obtained and the gear required to operate the valves although interlocking is quite simple A very powerful suction stroke is obtained in this pump because there is a tendency to draw in a charge of combustible mixture equal in volume to that of the expanded products Considerable throttling is therefore necessary and it is very easy to work this pump on a small suction producer plant offering high resistance to the passage of gas It should be stated that this pump ran perfectly well at the very first attempt to start it

The first pump invented and tested by the author was not one of those so far described but was a two cycle pump of more complicated construction There were as shown in Fig 8 two water valves a and b in the supply pipe one of which a was an ordinary mushroom valve normally held closed by a spring and the other a valve actuated by trip gear when the velocity of the inflowing water reached a certain predetermined amount The point of tripping was controlled by balancing the centrifugal force of the water flowing round a bend and acting upon a curved plate c against a spring d which tended to pull the plate into the stream lines The trip gear was also utilized to open and shut the inlet and exhaust valves on the top of the combustion chamber The action of this pump is as follows When the column of water in the discharge pipe has returned to give the compression stroke valve a is shut and valve b is open Ignition now occurs and the water is forced downward and outward from the combustion chamber so that the column of water attains velocity and as the expanded masses approach atmospheric pressure valve a opens and water is entrained to follow the moving column toward the high level tank Some water also flows into the combustion chamber and discharges the burnt products The rush of water round the bend in the supply pipe forces the curved plate into the recess sets the trip gear and opens the exhaust valve thus allowing the inflowing water to drive out the whole of the burnt products When however the velocity has diminished so that the curved plate can be pulled out by the spring valve b is dropped and the supply of water is cut off At this time however the outwardly moving column has not come to rest so that its further movement may be utilized to draw water from the combustion chamber This in turn will cause a new charge to be drawn into the chamber until the column of water ceases to move The return flow now commences, and valve a in shutting opens valve b compression occurs, and the cycle is ready to be repeated The cycle of this pump is as theoretically perfect as any of the others but difficulties were encountered in obtaining uniform working and the experiments on this type were abandoned

Pumps for High Lift – When it is desired to lift water to a height exceeding the head equivalent to the mean pressure of the indicator diagram an attachment is added at the end of the discharge pipe as shown in Fig 9 This addition may consist of a small air vessel placed at the end of the discharge pipe close to the large air vessel into which the high pressure water is to be delivered The inlet into the large air vessel is fitted with a non return valve and the action when working in conjunction with a two-cycle pump is as follows When the explosion occurs in the pump chamber the water is forced along the discharge pipe and rises in the small air vessel gaining velocity and compressing the air therein until the rise in pressure is sufficient to open the valve The energy of the water column is then spent in delivering water into the larger vessel and any backflow from it is prevented by the valve closing There is now sufficient energy stored in the compressed air in the small chamber to produce the return flow of the column toward the pump required to compress the next combustible charge, then the whole operation is repeated The amount of air in the small vessel has to be adjusted according to the pressure in the large vessel and the air may expand below atmospheric pressure on the return stroke

Pumps as Air Compressors The extreme flexibility of the author's system is shown by the readiness with which it can be adapted to the case of compressing air The column of liquid which reciprocates backward and forward from and to the pump can be made to enter an air compressor chamber fitted with suitable valves attached to the end of what has so far been called the discharge pipe The energy of the moving column of water is utilized to compress air and also to store sufficient energy in an elastic cushion to produce a return flow toward the pump to give the compression stroke This movement of the column also serves to draw a fresh quantity of air into the compressor The action may be seen from the diagram of Fig 10 where for the sake of variety the air compressor is shown attached to a four cycle pump The pump chamber A is connected to the compressor chamber B by means of the pipe C and the quantity of reciprocating water is such that when the level is high in the pump chamber it is low in the compressor chamber The air compressor chamber is fitted with an inlet valve D, an outlet valve F and two other valves I G which normally remain open under their own weight and are so placed and constructed that they allow air to pass them but not water since the impact of the latter is sufficient to close these valves Imagine that there is the usual compressed combustible charge in chamber A and a charge of air at atmospheric pressure in chamber B Ignition occurs in chamber A and drives outwardly the column of water so that the level rises in chamber B Valve G being open allows air to escape to atmosphere while the gases are expanding and imparting kinetic energy to the moving column, but so soon as the level of water reaches the bottom of pipe H which projects into the chamber the water trying to rise in this pipe shuts valve G The remaining air then suffers compression until the pressure at which the air is discharged is reached when valve I opens and air is delivered under pressure Next the water reaches the level of pipe I and in attempting to escape with the air shuts valve F There being no further outlet the imprisoned air is cushioned and the water column brought to rest The cushion now expands again and gives a reverse flow which drives out the products of combustion from the pump chamber gives the cushion stroke in that chamber and causes the cushion expansion and suction stroke which follows All that has happened in the compressor chamber is that the water level falls air is taken in and suffers compression again but not to the extent which causes any air to be discharged The pressure reached however is sufficient to give a second return flow and compress the newly drawn in combustible charge in the pump chamber and the cycle is ready to be repeated As the water level falls in chamber B valves I and G fall by their own weight It will be observed that by altering the extent to which pipe H projects into the air compressor chamber the quantity of air acted upon may be varied and this forms a ready means of adjusting the work of the compressor to deliver a greater quantity of air at a less pressure or a less quantity of air at a greater pressure Greater elasticity in meeting all possible conditions is provided in the case where water may be taken in or discharged at valves placed one close to the pump and one close to the compressor but it would occupy too much time to deal with the very large variety of air compressors which the author has invented in connection with his pumps Naturally the two cycle pumps are better suited for this class of work than the four cycle pumps and it should not be overlooked as there is no solid piston the space in the top of the air compressor chamber may contain vertical sheets of wire gauze which hold water and present a very large contact surface for cooling the air and rendering the compression almost isothermal The water which abstracts the heat does not remain in the chamber for in the case cited where water valves are used, water is taken in and discharged at each cycle and an automatic circulation through a cooling tank is set up It is only necessary to make the tank of sufficient capacity to effect the required cooling

(To be continued)

Various experimenters have recently endeavored to determine the exact distribution of the magnetic lines of flux in the air gaps of dynamos by means of testing coils The author of a paper read recently points out that these methods give only approximate values because the testing coils must have certain dimensions and therefore give only the mean of the fluxes within the space covered The author shows how to apply a correction to change the curve which is experimentally plotted into a curve which represents more correctly the exact distribution of the flux

COMBUSTION AND EXPLOSION.—I.*

A PRIMER ON EXPLOSIVES FOR COAL MINERS.

BY C. E. MUNROE AND CLARENCE HALL.

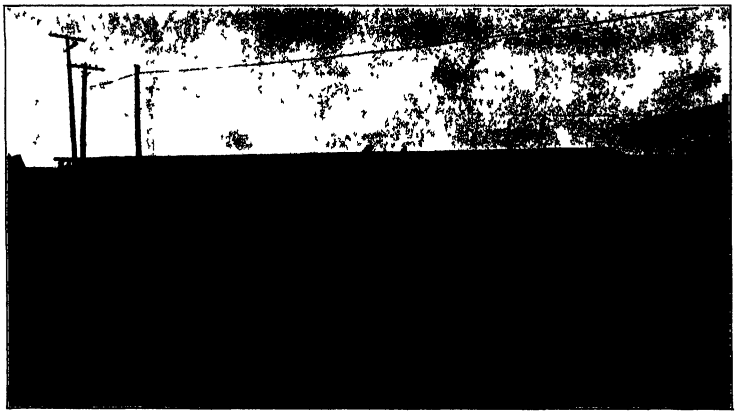
THERE is probably no activity of nature with which man is better acquainted or has been longer acquainted than with fire, of which he has made use from the earliest days for warming his body, cooking his food, giving him light, and in more recent times for breaking down rock, for making steam, and for other purposes. He has observed that a great number of substances can be burned, such as wood, charcoal, coal, sulphur, phosphorus, magnesium, and oil and gas in their many varieties, and many others, and he has made use of them to produce heat and light. He has noticed that when wood is burned in large sticks it is difficult to start the fire, and that where there are but a few large sticks the fire burns but slowly. When the wood is cut into kindlings and these are heaped together they burn more rapidly. When the kindlings are cut into shavings and these are piled together they burn still more rapidly, and when the wood is cut into dust by means of a saw and this dust is suspended in the air and set on fire it burns with explosive rapidity.

The same thing is found to be true of the other substances that burn under ordinary circumstances and are therefore called combustible. That is, the more finely divided they are and the more intimately this finely divided material is mixed with the air, the more rapid is the burning or combustion. This intimate mixture with the air is best attained with gases such as marsh gas (the fire damp found in mines), coal gas such as is used for lighting and acetylene, or with vapors such as those from gasoline, and when these are thus intimately mixed with the air the combustion goes on so rapidly that it takes the form of an explosion. Although an explosion is thus easily produced by mixing gas or vapors and air in the right proportions, explosions may also be obtained by mixing combustible dusts with the air in the right proportions and igniting them, and therefore we are not surprised to hear that explosions have been occasioned by mixtures of sawdust or flour dust or starch or sugar or soap or coal dust with the air. Many explosions thus produced are very violent and destroy life and property.

In each of the kinds of combustion or explosion that have been spoken of the combustible substance is mixed with air, and that the presence of air is necessary for the combustion is proved by the fact that when we cut off the air from contact with a burning body the fire goes out, or, as we say, we have smothered the fire.

The reason for this has been found in the nature of one of the several different substances that the air is composed of. This is the gas named oxygen, which is about one-fifth of the whole volume of the air. It is possible to separate this oxygen from the air, and when this has been done and burning bodies are brought into contact with this separated oxygen it is found that they burn much more rapidly than in air and that the combustion is much more brilliant. By repeated experiment it has been proved that all ordinary combustion is caused by the combination of the combustible substance with this oxygen of the atmosphere. Air deprived of its oxygen will not support combustion or life.

In view of these facts, and in view further of the fact that there are other substances in nature besides air that contain oxygen and will give up this oxygen to combustible substances, it would seem probable that combustion could be brought about through the aid



GAS AND DUST GALLERY No. 1, PITTSBURG TESTING STATION

EXPLOSION FROM COAL DUST IN GAS AND DUST GALLERY No. 1, PITTSBURG TESTING STATION of such oxygen-containing bodies, and this was long ago proved to be true One of the first if not the first, of such bodies that became known to man is saltpeter also called niter, or potassium nitrate, which, because it occurs as a white efflorescence like frost on the surface of the soil in India has been called India saltpeter although it has been found to some extent in many parts of the world

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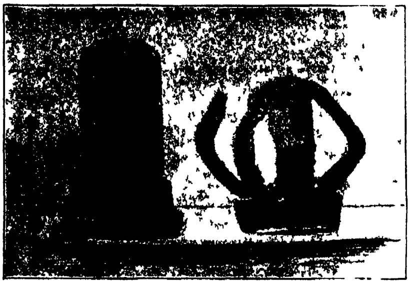
* Abstracted from Bulletin 423, published by the United States Geological Survey.

If solid saltpeter in the dry condition is mixed quite thoroughly with a solid combustible substance such as charcoal the mixture burns easily when once it is ignited The advantage of such a mixture is that the oxygen which is to support the combustion is in close contact with the charcoal which is to be burned and that, therefore this substance or mixture can be ignited and will burn without contact with the air and will so continue to burn until the charcoal is completely consumed As a result of the burning of the charcoal or carbon with the oxygen of the saltpeter a gas is formed As another result of the burning of this mixture of charcoal and saltpeter heat is produced, and this heat warms up the gas so that if it is unconfined its volume becomes greatly expanded and if it is confined it exerts pressure and does work Hence, if such a mixture be burned in the bore hole of a rock, it may break down the rock or in the barrel of a gun it will drive out the bullet

It is found however that it is not easy to ignite such a mixture of charcoal and saltpeter even when mixed in the best possible way and to overcome this difficulty use is made of another substance that ignites easily one which on burning gives out heat enough to ignite the mixture of charcoal and saltpeter This substance is sulphur or brimstone such as has been used in the past for the tips of sulphur or brimstone matches for which the same object of easy ignition was sought So eventually the mixture has been made of charcoal and saltpeter and sulphur, which are finely ground and closely mixed and then formed into grains and such a mixture is called gunpowder As has been pointed out it is simple combustion that takes place when such mixtures are set afire but on account of the thoroughness of the mixing the proportions in which the different substances are mixed and the way in which the material is finally made into grains this combustion may proceed so rapidly that there is an explosion which is powerful because the solid mixture occupying a very small space gives on combustion a large volume of highly heated gases



EXPLOSION OF HIGH EXPLOSIVE IN BOMB FILLED WITH WATER

SCREENS FOR SEPARATING DIFFERENT SIZED POWDER GRAINS

About 1821 there was discovered in the desert regions of Peru and Chile another saltpeter sodium nitrate which has come to be known by the name of Chile saltpeter Like the India saltpeter potassium nitrate it contains oxygen and it will give up its oxygen to combustible substances with ease at a relatively low temperature Hence a mixture of it with charcoal (known also as carbon) and sulphur makes a body similar to that produced with the India saltpeter and since 1857 such a mixture has been extensively used, especially in this country, for blasting in rock and in mines

Besides the India and the Chile saltpeters many other solid substances that contain oxygen and will give up their oxygen easily on heating to combustible substances have become known and many of them have been tried in the formation of the explosive mixtures Though one or two of them are used to some extent, as will be shown further on none are used so largely as the saltpeters.

It has also been found that we can get the oxygen out of the saltpeters in other ways than by heating an explosive mixture, as, for instance, by heating either the India or the Chile saltpeter in a proper manner with sulphuric acid when we obtain from them nitric acid which contains all of the oxygen originally in the saltpeters It has further been found that when substances like cotton or starch or glycerin are treated with nitric acid in the proper way there are formed from the cotton gun cotton or nitrocellulose as it is also called from the starch nitrostarch from the glycerin nitroglycerin and through this means the cotton the starch and the glycerin which are all combustible substances are converted into substances much more highly explosive and more powerful than mixtures made with the saltpeter and sulphur and combustible substances In fact such bodies can be made to explode by a shock such as is produced by a detonator or blasting cap when fired in contact with them and the explosion is extremely rapid and very much more powerful than that of the saltpeter mixtures

It has also been found that by the action of alcohol upon nitric acid solutions of metals such as copper or silver or mercury under proper precautions substances may be formed which are still more sensitive and still more violent in their explosive effects than guncotton or nitroglycerin The best known and the most widely used of these substances is fulminate of mercury When dry this substance is so sensitive that a very slight blow very little friction or a slight rise in temperature will cause it to explode and on explosion it produces a shattering effect upon any substance with which it is in contact Moreover the character of its explosion is such that if but a small mass of it is exploded in proper contact with guncotton or nitroglycerin or dynamite or other similar explosive it will cause each of them to undergo a very violent explosion which also will produce a shattering effect on the bodies with which they are in contact

From what has been said it will be seen that there are at least two classes of explosives One class is the saltpeter mixtures in which an explosion is brought about by simple combustion that proceeds rapidly and gives rise to a large volume of highly heated gases though almost one half of the mass remains as a solid residue Explosives of this class exert a relatively slow pushing effect upon the substances with which they are in contact when they explode and are called low explosives In the other class are explosives of the character of guncotton and nitroglycerin which undergo explosion by being suddenly and wholly resolved into a large volume of highly heated gases the change proceeding many times faster than the combustion that takes place in the saltpeter class of explo-

EXPLOSION FROM FLOUR IN MILLS AT MINNEAPOLIS IN 1878.

sives. Because of their speed and power these explosives have a shattering effect upon the substances with which they are in contact and are known as "high explosives," and also sometimes as "detonating" explosives.

Every explosive when exploded exerts its pressure in every direction. When laid on top of a rock and exploded, gunpowder and other low explosives do not lift the rock because they explode so slowly that the gases formed can lift the air above them and escape, but dynamite, fulminate of mercury and other high explosives if laid upon brittle or soft rock and detonated may shatter it because they explode so quickly that the gases formed cannot lift the large volume of air which confines them without pressing back forcibly against the rock. This confinement by air is not, however, close enough to give the best result with any explosive. By boring a hole in rock and tamping the explosive firmly in it, gunpowder and other low explosives may be made to break the rock, or a much less quantity of high explosive will break the rock than is required to break it when laid upon it. Confining an explosive is the cheapest and best way to use it.

It is foolish and dangerous for an inexperienced person to attempt to manufacture any kind of an explosive except under the supervision and direction of a trustworthy person who is skilled in the art. Many serious accidents which have destroyed lives or inflicted injury on persons and property have been caused by such attempts.

(To be continued.)

A NEW EPOCH IN NATURAL SCIENCE.

THE EARTH'S PENDULATION AND ITS EFFECT.

BY DR. LUDWIG STABY.

It has long been known that the earth's surface has experienced great changes, which have been manifested most clearly and strikingly by variations in the distribution of land and water. Extensive areas of the present land surface were once deeply submerged and former continents have vanished in the sea, leaving only their mountain peaks visible as islands.

The study of fossil remains and the effects of glaciation prove that the earth's surface has undergone great changes. Hence we speak of definite and successive geological periods. The change is still in progress. The areas of the oceans and the larger lakes are continually varying. In the North American chain of great lakes, for example, the water level is steadily rising (relatively to the shore) in the eastern lakes, Ontario and Erie, and as steadily falling in Lakes Huron, Michigan and Superior, the western members of the chain. Coral reefs are rising in some parts of the world and sinking into the sea in other parts. The Hawaiian islands are continually rising, while Helgoland is as surely sinking. These and many other remarkable and closely related facts have long been the objects of detailed examination and calculation, but until recently no explanation of them has been found.

Now, however, an ingenious theory has been advanced to account for the changes in the earth's surface by Paul Reibisch, an engineer, and Prof. Simroth, a zoologist. The new theory, which is called by its inventors the pendulation theory, has already produced very surprising results and it appears destined to throw a flood of light upon this hitherto dark field of science and to furnish a very simple explanation of many puzzling facts.

Everyone knows that the earth performs two movements, daily rotation on its axis, which produces the phenomena of day and night, and an annual revolution round the sun, which causes the change of seasons. But in addition to these two principal movements the earth must oscillate in some way in order to account for many indisputable facts, such as the gradual advance of the beginning of spring and autumn. The precise character of this oscillation remained unknown until Paul Reibisch undertook an elaborate and exhaustive calculation which led him to the conclusion that the earth's poles are not fixed in the earth but perform slow and regular oscillations in such a manner that the north pole, for example, moves gradually toward the equator along a certain meridian and, after a definite interval of time, returns along the same meridian to its mean position, and then proceeds to make a similar excursion on the opposite side.*

This regular oscillation of the earth's axis, although exceedingly slow (its period is calculated as at least 20,000 years), must produce great changes in the earth's surface. The displacement of the axis is equivalent to a change in the direction of rotation which changes the direction of the centrifugal force at every point and produces a tendency to flattening at the new positions of the poles and bulging at the new equator. The solid rock masses of the continents in general withstand this tendency, but the water promptly yields to it. Hence, if the north pole moves toward Europe, European waters flow southward and the northern part of the continent gradually rises higher above the sea level, while regions nearer the equator appear to sink. The result is an increase in the area of Europe and a shrinkage of South Africa. We are now living in a period in which the north pole is receding northward from Europe, so that the change now in progress is the reverse of that sketched above. Europe is apparently sinking and shrinking, as is conspicuously evident in the case of Helgoland, while the Hawaiian islands, under the influence of the opposite phase of the oscillation, are rising from the sea and increasing in area.

According to Reibisch's calculations the poles oscillate along the meridian of the 10th degree of longitude east from Greenwich and its supplement, the meridian of the 170th degree west from Greenwich. These meridians form a great circle which passes through Germany, Italy and Africa and which is called the circle of culmination or oscillation. The polar distances and the latitudes of all places situated exactly on this circle change more rapidly than those of any other points on the earth's surface, because the pole is moving directly toward or away from such places. The rapidity and extent of the changes of latitude at other points are inversely proportional to the distances of those points from the circle of oscillation. There are two points of the earth's surface at which no change occurs. These points are equidistant from the circle of oscillation and each of them is equidistant from every part of that circle. These two points would be called, in the language of geometry, the poles of the circle of oscillation, and Prof. Simroth has named them the poles of oscillation. One of these poles is situated in Sumatra, the other in Ecuador. These are the only points of the earth's surface that always lie on the ever shifting equator, which oscillates about the line that joins them. Hence they are always subjected to the maximum centrifugal force and the line that joins them should be the greatest diameter of the earth. The observed fact that these points are situated at the ends of the greatest diameter, therefore, affords a strong confirmation of the pendulation theory. The remarkable phenomena observed in the great lakes of America are explained by the fact that the chain is bisected by the meridian of Ecuador (80 deg. W. long.) so that the eastern lakes are nearer one half of the circle of oscillation (the meridian of 10 deg. E.) and the western lakes are nearer the other half (the meridian of 170 deg. W.). Hence the present movement of the north pole, which produces a decrease in latitude and a rise of water in the eastern lakes, produces an increase in latitude and a fall of water in the western lakes. The variations in height of coasts and coral reefs and in area of continents and islands in all parts of the world can be explained in a similar way.

But these great geographical and geological effects of the earth's oscillation are vastly less important than the climatic changes caused by pendulation, for the moving pole carries the Arctic climate with it. These changes are greatest in places situated on or near the circle of oscillation (long. 10 deg. E. and 170 deg. W.), diminish with increasing distance from that circle and vanish completely at the poles of oscillation. Hence the climate of Sumatra and Ecuador remains unchanged through all time.

When we reflect that all human culture and all animal and vegetable life are primarily dependent upon climate, we can form some vague idea of the tremendous effect produced in the organic world by the earth's oscillation. In the course of generations both animal and vegetable species are compelled to adapt themselves to the gradual change in climate, to migrate, or to perish. These three are the only possible solutions of the problem of existence. Animals which, like the huge saurians of the past, were unable either to adapt themselves to changed conditions or to migrate have vanished from the face of the earth, while those which could migrate or adapt themselves have remained. As the climate changed most rapidly near the circle of oscillation, the general trend of migration must have been from that circle eastward and westward and toward the tropics. This explains the occurrence of like species in regions separated by extensive areas in which they do not occur, and the identity of the fauna and flora of tropical mountains with those of low lying plains in the temperate zones. The development of the great variety of animals and plants that filled the earth in the different geological periods can be explained only by the geological and climatic influences of a series of periods of pendulation. The theories of adaptation and natural selection, introduced by Darwin, are confirmed and made clear by the pendulation theory, according to which species were evolved in the greatest variety and to the highest stage of development in regions near the circle of oscillation, while comparatively little evolution was accomplished in places far removed from that circle. Thus the flora and fauna of Australia still remain at a stage of development which was passed ages ago on the other continents and present a singular survival of the forms of the tertiary period of geology, while western Europe and northern Africa, traversed by the circle of oscillation, have been the centers of creation of most of the animal and vegetable species of the eastern hemisphere. Prof. Simroth, in his book, gives an illuminating description of the distribution of extinct and living forms of animals and plants by the agency of pendulation.

Man is not exempt from the operation of the laws that govern other organic beings. Hence the cradle of the human race must be sought near the circle of oscillation, and, as a matter of fact, all known fossil remains of primitive man and the anthropoid apes have been found near the 10th meridian of east longitude. Here, too, must be sought both the beginning of civilization and its highest development, and so we find the first rude drawings of the cave dwellers in the most enlightened countries, England, France, Belgium, Germany and Austria-Hungary.

Hitherto the causation of the successive geological periods, including the glacial periods through which the earth has passed, has remained an inexplicable mystery, but this mystery becomes as clear as day in the light of the pendulation theory. Each distinct geological period represents a period of pendulation, a complete oscillation of the poles of the earth. During each of these periods great changes were produced in the distribution of land and water, in climate and, hence, in the character and the distribution of organic species. The history of these changes is written in the succession of geological strata and the fossils which they contain, and the making of this history will continue as long as the earth shall endure.

The cause of this vitally important oscillation of the poles of the earth will never be known with absolute certainty, although many plausible hypotheses may be advanced. The oscillation may have persisted, though reduced in extent, from the time when the earth was a mass of liquid. Reibisch and Simroth conjecture that a second moon which the earth once possessed, or some other small planet, came into collision with the earth in the region now occupied by Africa (so that that continent may be formed of the matter of the supposititious colliding planet) and that the impact caused the oscillation to which the name pendulation has been given. Whether this is or is not the true explanation, pendulation is certainly the result of cosmical events which will never be exactly known.—Illustrirte Zeitung.

From results of a series of 30 tests made with 2⅝ × 2¾ × 13⅞ inch prisms of 1:2 Portland cement mortar bonded at the ends and tested for flexure it may be concluded with some degree of certainty: (1) That the bond existing between new mortar or concrete and old, where the old surface is smooth, is very slight. (2) That about one half of the strength of the concrete is developed in a joint bonded (a) by roughening the old surface, (b) by applying a layer of cement paste, (c) or by providing the old surface with a bonding groove (in these tests, ⅞ × ¾ inch). (3) That a large part of the strength of the concrete, perhaps as much as 90 per cent, is developed where the old surface is roughened and a layer of cement paste is applied. (4) That such a solution as "Ransomite" practically takes the place of the roughening, since a bond made with it is otherwise similar to the one made in these tests by roughening the old surface and applying a layer of cement paste.—Raymond B. Perry, in Engineering News.

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* Dr. Clarke in this country has proven such a theory mathematically.—Ed. Scientific American Supplement.

NOTES ON HALLEY'S COMET.

INTERESTING FACTS ABOUT OUR CELESTIAL VISITOR.

PROF. E. E. BARNARD is probably the first astronomer who actually saw Halley's comet at this apparition, which was to be expected, since his vision is probably keener than that of any other American astronomer. Prof. Barnard picked up the comet with the 40 inch Yerkes telescope on September 16th. The following table, taken from Popular Astronomy, gives the various estimates of the diameter of the comet made by Prof Barnard between September 17th and November 30th The values must necessarily be discordant, but the mean will probably not be very far out

OBSERVED DIAMETERS OF HALLEY'S COMET

			″		Miles.	Weight.
1909	September	17	7 2		10,800	5
		24	11 1		15,900	5
		26	9 5		13,100	5
	October	17	10.0	±	11,200	1
		19	15 0	±	16,100	1
		26	15 0	±	15,100	1
	November	14	11 6		9,200	5
Mean	October	21			12,600	23

Hence its diameter at these observations is about one and one half times that of the earth Of course the diameter of the comet, when at its brightest, will vastly exceed this value

The Rev George M Searle calls attention to the fact that Halley's comet on its way out from perihelion will make as near an approach to Venus as to the earth. The figures, also from Popular Astronomy, are as follows

Heliocentric conjunction in longitude May 1.82, G. M. T.

	Helioc Longitude	Latitude	Radius Vector
Comet	269° 11′	+9° 14	0 646
Venus	269° 11′	0 48′	0 727

The distance of the planet from the prolonged radius vector of the comet is probably too great to involve it in the tail, and the appearance of the comet, as seen from Venus, if there should be anyone to see it, would be very fine

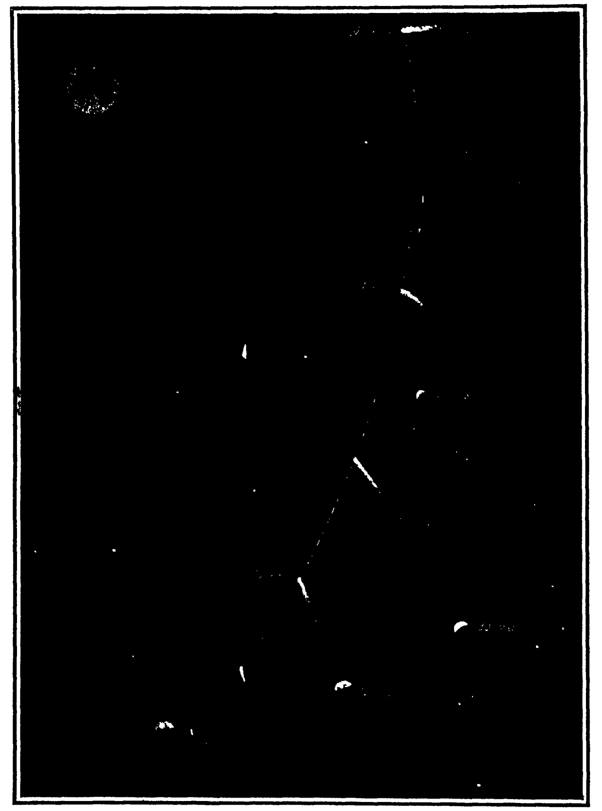
The spectacle will be interesting The approximate geocentric positions will be, on the morning of May 2

	α	δ
Comet	23h. 57m	+8 20′
Venus	23h 43m	2 40′

As Venus is very nearly of the same size as the earth, a good idea may be gained, from the view, of the relative dimensions of the comet and of our own planet The moon will be up, but in the last quarter

Halley's comet was not as brilliant as was expected in 1835, its last appearance This was due very largely to the relative positions of the earth, sun, and comet rather than to any loss in brilliancy of the comet itself It passed us about the middle of October on the way into perihelion, but at the time of perihelion and afterward was very far away, and on the other side of the sun to which latter circumstance its failure in the way of tail may well have been due, as the tail was turned nearly away from us At the time for the best development of it, the end of November and beginning of December, the comet was within a few degrees of the sun, as seen from the earth, and on the other side There seems, therefore, to be no special reason to expect the appearance of Halley this time to be inferior to that of 1759, as the circumstances now are remarkably favorable, except those concerning the moon.

Halley's comet will brighten rapidly during February and March, and will undoubtedly become visible to the naked eye were it not coming nearer into line with the sun all the time, so that in March it will be in deep twilight The comet is farther away than the sun, and will come into conjunction with it on March 25th At the time of conjunction the comet will be about six degrees north of the sun After conjunction it will come rapidly out of the morning twilight, and soon become visible to the naked eye toward the east for a short time before sunrise on each morning



From L'Illustration

On the night of May 18th, 1910, the earth will be immersed in the tail of Halley's comet. Twice in the last century a similar whisking of the earth by a cometary appendage occurred In neither case was anyone the wiser until, long after, mathematicians revealed the fact A comet's tail is so exceedingly attenuated that the vacuum in an incandescent lamp bulb is dense in comparison Hence stars are seen through a comet's tail without diminution in brightness

WHAT IS SCIENCE?

WHAT is the meaning of the word science? As in the case of so many words, its meaning has become confused by its partial applications, i e, by its application to a part only of its contents, and this has often led to a misapprehension of the relation of science and of the scientific man to life Science simply means knowledge, and to speak of scientific knowledge, as opposed to ordinary knowledge, is to use a redundant phrase, always supposing that we are using the word knowledge in its strict sense. Huxley defined science as organised common sense, by which, I take it, he meant knowledge of things as they are—knowledge the reality of which can at any time be checked by observation and experiment; for common sense, if it is anything, is the faculty by which we are made aware of reality. Science is sometimes spoken of as exact knowledge, but I am bound to say that I do not like the phrase exact knowledge; it seems to imply an insult to the word knowledge. Its use reminds me of a friend of mine who, when he was offered one morning at breakfast a fresh egg, mildly asked, 'In preference to what other kind of egg?'

Scientific men are not a class apart and distinct from ordinary mortals We are all scientific men in our various degrees If this is so, how comes it that the distinction is so often made between scientific men and non scientific men, between scientific knowledge and non scientific knowledge? The truth appears to lie here though it is true that all men possess knowledge i e, science, yet there are some men who make it their main business to concern themselves with some kind of knowledge, and especially with its increase, and to these men the term scientific has been technically applied Now the distinctive feature of these men, in virtue of which the term scientific is applied to them, is that they not only possess knowledge, but that they make it their business to add to knowledge, and it is this part of their business, if any, which justifies their being placed in a class apart from other possessors of knowledge.

The men who make it their main business to add to knowledge may be divided into two classes according to the motive which spurs them on (1) There are those whose immediate object is to ameliorate the conditions of human life and to add to its pleasures, their motive is utility, and their immediate goal is within sight Such are the great host of inventors, the pioneers in agriculture in hygiene preventive medicine, in social reform and in sound legislation which leads to social reform and many other subjects (2) There are those who pursue knowledge for its own sake without reference to its practical application They are urged on by the desire to know by what has been called a divine curiosity These men are the real pioneers of knowledge It is their work which prepares the way for the practical man who watches and follows them Without their apparently useless investigations, progress beyond the limits of the immediately useful would be impossible We should have had no applied electricity, no spectrum analysis, no aseptic surgery, no preventive medicine no anesthetics, no navigation of the pathless ocean. Sometimes the results of the seeker after knowledge for its own sake are so unique and astounding that the whole of mankind stands spellbound before them and renders them the same homage that the child does the tale of wonderful adventure such is the case with the work on radium and radioactivity which is at present fixing the attention of the whole civilized world Sometimes the work is of a humbler kind dealing apparently with trivial objects and appealing in no way to the imagination or sense of the wonderful such was the work which led to and formed the basis of that great generalization which has transformed man's outlook on nature—the theory of organic evolution such was the work which produced aseptic surgery and the great doctrines of immunity and phagocytosis which have had such tremendous results in diminishing human pain The temper of such men is a curious one no material reward can be theirs and as a rule but little fame Yet mankind owes them a debt which can never be repaid It is to these men that the word scientific has been specially applied and with this justification—they have no other profession save that of pursuing knowledge for its own sake or if they have a profession it is that of the teacher which, indeed they can hardly avoid —Prof A Sedgwick in an address delivered before the Imperial College of Science and Technology

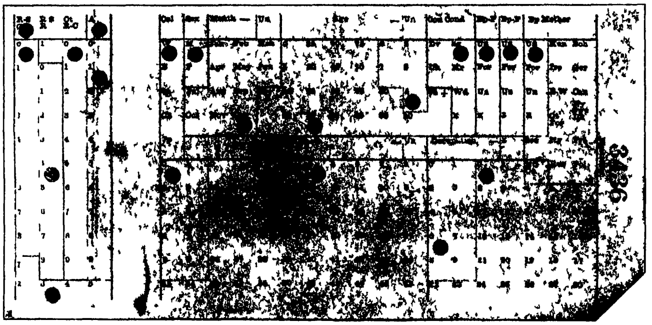
COUNTING OUR POPULATION BY MACHINE.*

A CARD CATALOGUE OF THE AMERICAN PEOPLE.

BY CENSUS DIRECTOR DURAND

ACCURACY is the fundamental requirement of all statistical work This means first accuracy in collecting the original material second accuracy in compiling and tabulating it and third accuracy in analyzing and interpreting it The first and the third stages in the process of statistical work are extremely difficult and it is concerning these that I wish especially to speak It is a matter of comparative simplicity to secure accuracy in compiling and tabulating statistics The principal problem here is to secure economy of time and money A few words only as to the methods of compilation and tabulation contemplated for the coming census will be sufficient

The population census of 1910 like that of 1900 will be tabulated by the use of punched cards Every person in the United States is given a card on which the facts with regard to sex race age birthplace birthplace of parents and the like are indicated by the punching of appropriate holes The number of persons possessing each specific characteristic or combination of characteristics which it is desired to show in the final tables is then counted by means of electrical tabulating machinery electrical contacts being made through the holes punched in the cards



ONE OF THE PUNCHED CARDS

The punching machines to be used at the present census differ very radically from those used before and will it is believed not only increase the rapidity of the work but tend to reduce the number of errors on the part of the clerks doing the punching With the old punching machine if an error was made in punching an item even though it might be the last item to be punched on the card the entire card had to be destroyed This meant a loss of time and also resulted in a temptation to the operator to let the error go uncorrected With the machines now to be used no hole is punched in the card until the keys for all the facts to be punched have been pressed and if the operator makes a mistake by depressing the wrong key he can correct it before the card is punched It was not found possible at the last census to check all of the cards back to the schedules and it will probably not be feasible to do so at this census Part of the cards punched by each operator are selected at random and compared back and if any appreciable percentage of error is discovered in these thus compared the other cards punched by the same operator are likewise compared

The tabulating machines to be used at the present census will likewise result it is believed in a material increase of rapidity and reduction of errors This is principally brought about by the fact that the results of the count for each unit of area are automatically printed whereas formerly they were registered on dials from which readings had to be taken and recorded by hand The reading of these dials took a large amount of time during which the machine was idle and inaccurate readings were not uncommon

At the census of 1900 the agricultural data were also handled by means of punched cards For each farm a large number of cards had to be punched as the number of facts recorded regarding a farm was far greater than the number of facts recorded regarding an individual in the population census At the present census it is the plan to do away with punched cards and probably to tabulate the data columns of figures by means of typewriters which also operate as adding machines giving the total for each column These typewriter adding machines as they are called are a new device of which there are several makes available Aside from the minor advantages of having the facts all plainly recorded in typewriting so that they can readily be looked up and compared back with the schedules in case of apparent error it is believed that a very marked saving in time will be secured in the editing of the returns for individual farms Unfortunately enumerators are bound to make a considerable number of errors in reporting farm data For example in reporting the number of bushels of grain raised on a farm it is easy for an enumerator to leave off a cipher or add an unnecessary one or to report a given number of acres in the crop without giving any product Because of the delay and expense involved it is not feasible to correct the great majority of these minor errors by correspondence with the enumerator or with the farmer concerned It is necessary to make arbitrary corrections in the office At the census of 1900 such minor errors were corrected by clerks examining the individual schedules and a very large expense was involved It is believed that by having the data for the various farms typewritten plainly in columns the eye can run down these columns and discover such obvious errors with great rapidity and it is hoped that several hundred thousand dollars of expense will be saved in this way

The tabulation of the manufactures statistics is a comparatively small matter since the number of establishments is but a small fraction of the number of farms covered by the agricultural census The exact method of tabulating these manufactures statistics has not yet been determined

Turning now to the more important subject of the means of securing accuracy in the original census returns collected in the field It is self evident that the entire value of the census depends on the securing of approximate accuracy in the original returns Absolute accuracy is out of the question and in fact a small margin of error does not seriously affect the value of the statistics but any considerable margin of error practically destroys their value No degree of accuracy in tabulating and no degree of skill and judgment in analyzing statistics can give value to data which were incorrect in the first place

It has too often been a vice of statisticians to present to the public tables purporting to show all sorts of important facts without due consideration of their truthfulness The general public who use the statistics—in fact even the trained statisticians who use them have in most cases no means of discovering the inaccuracy of such statistics and go on using them in misguided confidence The compiler of statistics has often been unconsciously perhaps careless as to their accuracy because of the lack of any possibility of detection The man who has charge of the collection of statistical data ought himself to be the severe and uncompromising critic of those data He alone has approximately adequate means of judging the degree of accuracy which has been secured, and it is his duty having done all that is possible to eliminate error to inform the public fully and frankly of the extent to which error presumably still persists So far from taking advantage of the fact that others can not discover the errors which are hidden away in imposing looking totals he should from that very fact recognize the more clearly his own duty to explain just how much or how little the statistics may be trusted

This does not mean of course that the statistician who knows that there are certain errors in his figures should straightway declare them of no value Statistics on certain subjects may be of very little value unless almost absolute accuracy is secured but there are many subjects as to which close approximations to the truth are almost as valuable as the exact truth itself It is the mark of the competent statistician to be able to decide approximately what the margin of error actually is and also to what extent the error vitiates the results As Josh Billings said 'It is better not to know as much than to know too many things that aint so'

At the census of 1900 and during the so-called intercensal period since that time the Census Bureau has done a great deal in the way of criticising its own statistics in the manner I have suggested, but I doubt whether it has yet been sufficiently emphatic in cautioning the public with respect to the existence of unavoidable errors. A striking instance appears in connection with the manufactures statistics of the census. Although the reports in various places have called attention to the impossibility of securing bookkeeping figures from many establishments and the necessity of accepting more or less rough estimates, yet these same reports have published figures purporting to show the total volume of the manufactured products of the United States down to the last single dollar—$13,058,562,917 being the figures given for the total value of manufactured products in the United States at the census of 1900. Fortunately the cents are not shown. The slightest consideration of the conditions under which a manufactures census is taken shows that the margin of error on a huge total like this may run into the tens of millions. Obviously the public should at least have the approximate character of such statistics constantly thrust before it by having them expressed in round figures. I think it desirable to express all very large totals of manufacturing statistics in millions, and in the case of the smaller figures which appear in the statistics for individual States and industries, to express the results in thousands.

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* [illegible] meeting of the American Statistical Association September [illegible] 1909

To criticise statistics, however, is easy; the difficult task is to improve them. The Census Bureau will have done part of its duty to the public if it gives warning regarding the margin of error in the statistics it publishes, but it is far more important that it should reduce that margin of error.

There are two means to this end. The first and more difficult is to secure better men to collect the statistics, the second is to simplify and clarify the inquiries.

The statistics of population and of agriculture are collected by a different force from that employed in gathering the statistics of manufactures. The population and agricultural data are secured by enumerators, of whom there will be about 6[illegible]000 at the present census, they in turn being appointed by the supervisors, of whom there are about [illegible]0. The difficulty of securing competent and faithful enumerators is very great. The length of service is very short, 15 days in the cities and 30 days in the country districts. The period is thus too short to justify a man who has a good job in quitting it, while on the other hand it is too long in most cases to enable such men to get leave from their regular work to take the census. Moreover, the pay is small, averaging perhaps three dollars per day in the country districts and a trifle more in the cities, practically the pay of ordinary mechanics. Not only, therefore, are most of those who seek to be enumerators men who from financial motives are able to command only moderate pay in their occupations, but many of them are men who can not command regular employment and who are looking for odd jobs.

REAR OF THE NEW CARD PUNCHING MACHINE

Consideration has been given by the census authorities from time to time to the plan pursued in Germany and some other European countries, by which census is taken chiefly or wholly by men serving without pay, who either volunteer their services from patriotic motives or who are required to act. I very much doubt whether conditions in this country are ripe for such a scheme. At any rate, nothing of this sort can be done at the present census. It may, however, be hoped that to some slight extent, and possibly to a considerable extent, men can be induced to accept the position of enumerator from interest in the work rather than for the compensation involved. I hope that a considerable number of colleges and universities of the country may see fit to give leave of absence to their students for the short time required to do this work of enumeration. The college student is a very useful enumerator in some cases, but it is exceedingly desirable that enumerators should actually live in the districts where they work, and there are multitudes of districts where no college students reside, or where such students are in institutions hundreds or thousands of miles from their homes. Another class who can render good service as enumerators are school teachers, but with the enumeration taking place in April and May instead of June as formerly, few school teachers can be spared from their duties to take the census.

The primary responsibility for securing efficient enumerators must rest with the supervisors of the census. It has been suggested from time to time that more efficient enumerators might be secured by competitive examination open to everybody. There is no doubt that if the expense and time required were not prohibitive it would be advantageous to hold such an examination, although it would be necessary, instead of merely selecting those whose ranking in the examination was the highest, to refer all candidates who passed to the supervisor and allow him to select those whose personal characteristics, such as can not be tested by any written examination, were most suitable. The difficulty with such an open examination is the expense and delay involved. It is probable that for the [illegible]000 places there would be several hundred thousand candidates, and the grading of their papers would require a large force for a long time. At some future census this plan might be worth a trial, but it can scarcely be attempted at the present census within the limits of time and appropriations set by law.

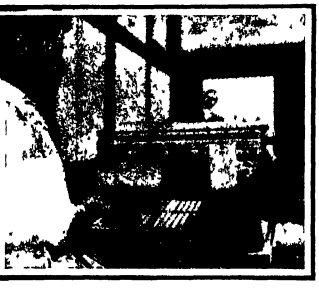
The Census Bureau does, of course, undertake to protect itself against such obviously incompetent enumerators as the supervisors through political influence or through oversight may happen to choose. At the last census the enumerators recommended by the supervisors were all subjected to a test examination, and the same policy will be pursued this time. About one-sixth of the candidates selected by the supervisors were rejected as the result of this test in 1900. It may be wise to make the test at the present census a trifle more severe than at the twelfth census. At best, however, such an examination can do no more than to eliminate those who cannot write plainly and who are clearly lacking in an understanding of their duties. It can do little to assure the selection of men of industry, tact, or honesty. The judgment, efficiency, and integrity of the supervisors must be the prime reliance for securing enumerators who possess these fundamental qualifications.

Photographs copyright 1909 by Waldon Fawcett

THE NEW TABULATING MACHINE

I hope and believe that the supervisors at the present census are on the whole a higher type of men than those at any preceding census. The compensation offered to supervisors is somewhat more than ever before, but it is not really an adequate remuneration for men of the character needed. I believe that a very considerable proportion of the supervisors who have been appointed are men who in their regular occupations or professions are able to earn more than the supervisors' pay, and who have accepted the positions because of the honor and responsibility involved or from patriotic motives. There has, however, been no new departure with respect to the general method of selecting supervisors, save only that in large cities or most of them selections have largely been made independently of political recommendations.

The work of collecting statistics of manufactures and mining is in some respects even more difficult than that of collecting population and agricultural statistics. The number of employees required, however, is much more limited, and consequently it is possible to employ more elaborate methods of selecting them. The manufactures and mining statistics are practically all collected by men known as special agents. These are appointed by the director, and the law does not require any examination, but it is my intention nevertheless to make the appointments as the result of competitive examination, from which, however, men who have had previous successful experience in field work for the Census Bureau will be excused, as well as men who have successfully passed the somewhat similar examination for the position of special agent in the Bureau of Corporations. It is evident that an ordinary civil service examination, with its tests merely of what a man knows, is not adequate for the selection of men to do the responsible and largely independent work of visiting manufacturing and mining establishments to secure schedules from them. Consequently, following a precedent set by the Bureau of Corporations, and to some extent employed also in other more advanced scientific civil service examinations, the examination for special agents will consist in part of the presentation of evidence regarding the applicant's previous education and experience, while the remainder of the examination will be a very practical test of his ability to fill out a manufactures schedule. For those who are to do the simpler field work this test will be little more than reproducing on a schedule a set of facts which have been stated in narrative form, but for the agents who are to visit the more important establishments, or who are to have charge of other agents, the test will consist of the filling of a schedule from somewhat complicated details in a hypothetical balance sheet, income account, and payroll. Moreover, not being bound by any legal requirement to take the man with the highest rating, the appointing officers of the bureau will be able to give proper attention to such matters as personal address and tact, [illegible] which can not be tested by any examination. We hope to secure as special agents largely young college and university men with some training in economics and statistics, or who have been bookkeepers of the more advanced type in manufacturing establishments, or who have had other direct business experience.


FRONT VIEW OF THE CARD PUNCHING MACHINE

PREPARATION OF SCHEDULES

The form of schedules on which census statistics are collected has an extremely important bearing upon the accuracy of the results obtained. In the drafting of a schedule the first consideration is naturally what information it is desired to secure, but it is equally important to consider how far it is possible to obtain information accurately. There are always abundant suggestions from people interested in different economic and social problems as to points which ought to be included in the schedules, and there is comparatively little danger that a statistician in public office will neglect to make inquiries merely because he does not know that the information would be of utility to the public. There are not so many people, however, who are well informed as to the difficulties of securing statistical facts, and one of the most important tasks of the statistician is to determine what facts can be secured with accuracy by the means which he has at his disposal. Not only are some inquiries which if answered correctly would furnish very valuable information in themselves quite incapable of correct answer under existing conditions, but the multiplication of inquiries which separately are quite capable of accurate answer tends to lessen the accuracy of the replies to all of them. A schedule may, in other words, easily be overloaded. The enumerator or special agent collecting the statistics becomes discouraged if too much is asked of him, and the person to whom he addresses his inquiries becomes still more discouraged, not to say annoyed and confused.

Every reduction in the number of inquiries contained in a census schedule tends to greater accuracy in the returns except of course in those cases where such reduction in the number of inquiries obscures the clearness of the schedule. Some details in schedules themselves comparatively unimportant are often necessary in order to make clear what is intended to be included in a total.

This demand for reduction of the number of inquiries and simplification of them in the interest of accuracy in the returns themselves is in some cases opposed by the likewise important demand for details which will permit an accurate analysis and interpretation of the statistics. In other words, the lower form of accuracy sometimes stands opposed to the higher form which seeks the true spirit of the phenomena investigated.

For example, take manufactures statistics. In many industries the entire technical and economic conditions are rapidly changing, and broad general interrogatories, even though answered with the utmost accuracy, give results which are not comparable with those of preceding censuses because of such changes in conditions. One instance of this character happens to have come to my personal attention recently. The schedules for the petroleum industry call for the value of the different kinds of oils produced, including the containers in which they are shipped from the refinery. Twenty or thirty years ago nearly all the oil was shipped from refineries in barrels or other small containers, the value of which has represented a large fraction of the total value of the product. At the present time the larger part of the products of refining is handled in bulk without containers. A comparison of the average value computed by dividing the number of gallons into the total value of the product including containers from one census period to another is therefore highly misleading. The higher form of statistical accuracy practically compels the insertion of somewhat burdensome questions designed to separate the value of the product contained from that of the containers.

It is evident therefore that it is an exceedingly important and difficult task to frame a schedule which shall combine simplicity with that completeness which will permit correct interpretation.

The manufactures, mining, and agricultural schedules are necessarily the most complicated which the Census Office employs. The office has spent a very large amount of effort during the present summer in studying these schedules and has called to its assistance a number of economists and statisticians from the universities, as well as men connected with the practical work of the Department of Agriculture and the Geological Survey, and men actively engaged in business. I hope that we are succeeding in materially reducing the burden upon the enumerators and the special agents, while at the same time cutting out few inquiries of material value and adding some which will make results more intelligible.

To illustrate what has been undertaken, I will call attention to two very material changes which have been made in the schedule of manufactures. At the censuses of 1900 and 1905 that schedule called for the average number of men, the average number of women, and the average number of children under 16 employed during each month in each establishment. To answer this interrogatory with strict accuracy would have required the special agent or the manufacturer to go in detail through every pay roll of the year, usually either 52 or 26 in number, counting the number of men, women, and children separately on each, the segregation of those under 16 involving peculiar difficulty, and averaging the count for each month. To do this and at the same time to answer the inquiry regarding classified wages, to which I will shortly refer, would in my opinion have required ten times as much time as to answer all of the inquiries on the schedule put together. As a matter of fact practically none of the returns were, I am convinced, based on analysis of the pay rolls. They were in nearly all cases mere estimates made more or less offhand by the manufacturer or his bookkeeper, and many months had elapsed before the returns were made. There is every reason to believe that they were often very wide of the mark.

The schedule as it has been revised for the present census calls for the number of men, women, and children employed during one specified week only, and for the total number employed without distinction of age or sex on the first pay roll of each month. The relative extent to which women and children are employed will be ascertained approximately from the figures for the selected week. If the total number of employees on the first pay roll of each month is returned with approximate accuracy, then the average of these twelve pay rolls will unquestionably show very closely the true average number of employees during the year. We hope to be able to induce special agents and manufacturers in a large proportion of cases to answer this interrogatory from actual bookkeeping figures, and if we succeed the greater accuracy will far outweigh any apparent sacrifices in the amount of information obtained.

At the last census of manufactures a question was included in the schedule which called for the number of employees classified according to their earnings for one week of the year, and separating men, women and children under 16. This is a question which if correctly answered would furnish information of very great value. We have been convinced, however, that for many establishments correct answers cannot be obtained, and that for other establishments the amount of effort required to obtain correct answers is so great as scarcely to justify the expense, while also tending to injure the accuracy of all the data called for on the schedule. Strictly speaking, this inquiry falls within the field of the Bureau of Labor rather than that of the Census Bureau. It may be, however, that at another census, in order to take advantage of the fact that census agents are to visit every manufacturing establishment, we shall ask the authority of Congress to provide a special schedule covering classified wages and an extra appropriation to cover the expense of getting it properly filled from actual pay rolls. It would not be essential that returns of classified wages be secured from every establishment. If such returns could be secured accurately for even 50 per cent of the employees they would be of very great value, and the agents should be specifically instructed to accept no estimates.

What has just been said regarding these two changes in the manufactures schedule will illustrate what I said before with regard to the increase in accuracy which can be secured by simplification of the schedules. The schedule of manufactures hitherto has been overloaded. Since special agents and the manufacturers who fill them were practically forced in many cases to make estimates in replying to the interrogatories regarding the average number of employees and classified wages, they were tempted to regard estimates as sufficient for the replies to all the interrogatories of the schedule. The intellectual integrity of the special agents was undermined by requiring of them work which they knew could not be done accurately within the time which they were allowed.

ANALYSIS AND INTERPRETATION OF STATISTICS.

It is a commonplace of statistical science that the mere presentation of figures has comparatively little value without analysis and interpretation.

The statistician owes to the public the duty of properly analyzing and interpreting his material, not simply in order that the public may get the full value of the results, but, what is more important, in order that false and misleading interpretations may be forestalled and prevented. Whether the untruthfulness has been due to intentional misrepresentation or to ignorance, census statistics have probably been made the basis of more fundamentally untruthful speeches and articles than any other set of facts. The reports of the Census Bureau in the past have contained many warnings against such misleading use of their contents, but such warnings are all too often disregarded. "Liars and fools," to use perhaps exaggerated expressions, will continue to abuse census statistics whatever the government may do to prevent it. We shall attempt at the present census, however, to make the warnings against such use of the figures even more numerous and more emphatic than in the past, in order that the man of ordinary intelligence may in general escape the pitfalls. Too often the warning has been posted in an inconspicuous place, hidden away in some long page of text, when it should properly have been presented in the most conspicuous place in the text, or even in the headings of the tables themselves, since most people, even those of considerable economic training, usually pay little attention to the text and assume that the tables mean what on their face they purport to mean. These warnings should relate not merely to inaccurate conclusions from the figures, but also, where necessary, should caution the reader against assuming a degree of accuracy in the statistics which does not exist. One of the most important duties of the census statistician is, as I stated at the beginning, to discuss frankly and clearly the margin of error in the returns.

In addition to increasing the frequency and the emphasis of the warnings against improper use of the census statistics, it will be desirable in my opinion to extend somewhat further than hitherto the analysis and interpretation of the statistics, at least in certain directions. A desirable feature of this increased analysis will be the publication of additional monographs dealing with particular economic and social problems. Many people have little interest in census statistics in general, but are profoundly interested in the data regarding some particular subject, and such data should be available for their use in separate form so far as possible. You will recall, for example, the exceedingly able monograph prepared by Dr. Willcox on the basis of the census of 1900 and dealing with the negro. We contemplate another monograph on this subject at the present census, and also similar monographs dealing with the foreign born, with the family, with occupations, and perhaps with other similar subjects connected with the population statistics. Monographs dealing with particular branches of agriculture are also contemplated. The practice of presenting the statistics of the leading manufacturing and mining industries in monographic form has already been pursued quite generally at previous censuses.

Proper analysis and interpretation of the census statistics will call for the employment of a considerable number of statistical experts in addition to those on the permanent roll of the census. A considerable proportion of the tabular and text analysis and interpretation of the statistics at the previous census has been committed to men of comparatively little economic and statistical or business training and experience, although beyond question much of the work has been done by highly competent men. We hope to be able to enlist the service, for periods ranging from a few months to a year or two, of a considerable number of expert special agents to aid in the work of analyzing and interpreting the returns. Hitherto the limit of salary for temporary expert service of this sort has been altogether inadequate, $6 per day. In July of this year Congress passed a bill authorizing the payment of not to exceed $8 per day to 20 expert special agents. The director had asked that the limit of pay be fixed at $10, and it is possible that Congress will this winter be again urged to establish that rate. Even $10 per day is but moderate compensation to offer to men who possess the necessary qualifications for this work, most of whom are already earning at least that much in permanent positions.

It is not the intention to employ exclusively men who have had university training in economics and statistics in this advanced work of analyzing and interpreting the census material. Particularly in the case of the manufacturing, mining, and agricultural statistics it will be desirable to obtain the service of men of practical business experience. This policy has been pursued in fact to a considerable extent at previous censuses. I believe, however, that in some cases the economy as well as the scientific value of this work has been impaired by having too much of it done by men who were not actually present in Washington, but who gave only such time as they could spare from their regular professions or occupations to the work at their own homes, coming only occasionally to Washington for consultation. This practice has tended to undue lack of uniformity in methods and has placed too great responsibility on single individuals. While specialization has its great advantages, it should be combined with consultation with others working on kindred topics.

The general policy of insisting that for the most part at least the expert special agents who analyze the statistics and prepare the text of the reports shall be present in Washington at least the greater part of the time will in some cases exclude practical business men such as have formerly been employed for that purpose, because of their inability to give up even temporarily their regular duties. We shall, however, employ such men as consulting experts, having them come occasionally to Washington or sending the expert special agents who are assigned to particular tasks to consult with them at their homes. We believe that the undivided attention of men of high capacity and of general statistical and economic training, even though they may previously have had little direct experience in the particular subject entrusted to their charge, will enable them to become sufficiently expert in a comparatively short space of time to handle the statistics even more satisfactorily than can be done by men of more practical experience who are not personally present and can give only a part of their time.

A CENT'S WORTH OF ELECTRICITY

AT the average rate for power paid by the ordinary consumer, says Harper's Weekly, a cent's worth of electricity will operate a 12-inch fan for 90 minutes.

Will operate a sewing machine motor three hours.

Will keep a six-pound electric flatiron hot 15 minutes.

Will make four cups of coffee in an electric coffee percolator.

Will keep an 8-inch disk stove hot seven minutes, or long enough to cook a steak.

Will operate a luminous radiator eight minutes.

Will bring to a boil two quarts of water or operate the baby milk warmer twice.

Will make a Welsh rarebit in an electric chafing dish.

Will operate a 7-inch frying pan 12 minutes.

Will keep a heating pad hot two hours.

Will operate a griddle eight minutes.

Will run the electric broiler six minutes.

Will run a massage machine nearly four hours.

Will keep the dentist's electric hammer and drill going 90 minutes.

Will keep the foot warmer hot a quarter of an hour.

Will run an electric pianola one hour.

Will vulcanize a patch on an automobile tire.

Will heat an electric curling iron once a day for two weeks.

Iaque argentia is a metallic tin obtained by precipitating solutions of tin by means of zinc. With the addition of an adhesive it can be used for making silver coatings on paper, wood, and metals.

AEROPLANE ACCIDENTS.*

WHY THEY OCCUR.

The death of Delagrange, through the falling of his aeroplane, has two special features of technical interest. In the first place, it is the first fatal accident which has happened with an aeroplane of the monoplane type; and in the second it is the first which appears to be distinctly due to a failure in the main structure of the machine used. The first of the points just named is of considerable interest, from the fact that it seems to be generally assumed that, whatever other disadvantages it has, the biplane is a safer machine than the monoplane. Yet it is undoubtedly a fact that the greater number of accidents have happened to the biplane. Previous to the death of Delagrange there had been four fatal accidents with modern flying machines—viz., Lieut. Selfridge was killed when making an ascent with Orville Wright on a Wright machine in America; Lefebre lost control of his Wright machine, which therefore fell; Lieut. Ferber had a fall in his Voisin machine, from which he died soon after; and Fernandez was killed when flying in a biplane of his own design.

One at least of these, namely, Lieut. Selfridge's death, appears to have been due to the failure of the machinery, a broken propeller having been the primary cause of the fall. It is also possible that Lefebre's mishap was caused by the control wire breaking and the machine becoming unmanageable in consequence. It is, however, inevitable that in case of a fall the machine should be so damaged that it is impossible to tell what happened from the broken parts; and if the pilot is killed, it is difficult to ascertain how the accident took place. In the cases of Capt. Ferber and Fernandez there is no evidence that any part of the machine failed; and in the cases of Lieut. Selfridge and Lefebre the main framing did not fail. In the case of Delagrange's accident, however, there seems good reason to suppose that the main framing forming one of the wings gave way altogether, the machine falling in consequence.

Curiously enough, Santos Dumont had an accident the very next day from an almost exactly similar cause. In this instance the good fortune which has followed this experimenter throughout his aerial career continued, and he did not lose his life, but there is no doubt that the machine fell completely. In his case it is definitely stated that the accident was caused by the fracture of one of the wires which takes the upward thrust of the wing.

In the case of the biplane the top and bottom members are both of wood, with wood struts, the whole being braced with very numerous ties of wire. In the case of the monoplane, however, the main spars of the wing are trussed to a strut below by a comparatively small number of wires. The structure of each wing is, in fact, very much like that of the mast and rigging of a sailing boat, the main spars taking the place of the mast, while the wire stays take that of the shrouds. A very important difference, however, is that the mast of a sailing boat is almost invariably provided with a forestay to take the longitudinal pressure when going head to wind, while the wing of an aeroplane often has no such provision, the longitudinal pressure due to the air resistance being taken entirely by the spar.

It is possible that this had something to do with the recent accident with which we are especially dealing, for the monoplane on which Delagrange met his death had been fitted with an engine of double the power originally provided by the maker, who is reported to have given this as the probable reason for the failure of the machine. As the new motor was of a very light type, the extra weight, if any, was quite a negligible proportion of the total weight of the machine. The vertical stresses on the wings and their supporting wires would therefore not be materially increased; but as the more powerful engine drove the wings a great deal faster through the air, the stresses brought upon them by the air resistance would be very considerably increased, and unless provision was made to meet this the factor of safety would be very materially reduced. Whether the failure of the wing was actually from longitudinal stress or from the supporting wire breaking, as in the case of Santos Dumont, will probably never be accurately known; but it is quite clear that the question of ample strength to resist longitudinal stresses should be very carefully considered, especially when putting more power into an existing machine.

The question of the most suitable material and fastenings for the supporting wires is, moreover, a matter which requires very careful consideration. In the case of biplanes the wires are so numerous that the failure of one or even more may not endanger the whole structure; but those of the monoplane are so few that failure of even one wire may mean a broken wing. In this respect, as in others, the position is, in fact, exactly the same as the mast of a sailing boat, and one would expect therefore that the same materials would be suitable. At present, however, the stays of the aeroplane wings are almost invariably solid steel wire or ribbon, while the shrouds of a sailing boat are invariably of stranded rope, solid wire not having been found satisfactory. There is no doubt that, weight for weight, the solid wire will carry a heavier strain than the stranded rope when tested in a machine; but it is found in practice that it is not so reliable. The stranded rope seldom breaks without warning, but several strands go before the whole gets unsafe. As the breaking of these is very easily seen, an unsafe rope can always be replaced before actual breakage; whereas in the case of the single wire there is nothing whatever to show whether it has deteriorated or not.

It does not, of course, necessarily follow that what is most suitable for a boat is also the most suitable for an aeroplane; but as the conditions are so very similar, it seems very doubtful policy to use in an aeroplane what is not good enough for a boat.

Incidentally, the Delagrange accident shows what may be the evil effects of striving after records. What is wanted to make the aeroplane of practical use is that it should be reliable and safe. The tendency of record-breaking machines is the exact opposite of this, as the weights of all the essential parts must be cut down to the finest limit possible in order to provide enough engine power, gasoline, etc., for the record run. It is, in fact, generally found in engineering that the design and materials which will give the best results for a short time are essentially different from those which are the most reliable; and striving after records consists simply in neglecting reliability and safety to the utmost extent to which the pilots can be persuaded to risk their necks.

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* Engineering, London.

THE COMMAND OF THE AIR AND ITS EFFECT ON LAND WARFARE.

The attitude of some of the continental powers as to flying machines for warfare, and the fact that much experimental work is being done in France and Germany as well as in this country, justifies further consideration of the effect which aeroplanes and dirigible balloons may have on land warfare, a subject to which we referred in a recent article. The points of direct importance are as to what factors the ultimate command of the air will depend on, and what effect it will have on land warfare.

Taking the latter point first, we may probably quite disregard the idea of balloons being used to drop bombs into towns for the sake of wantonly destroying private property. It is quite true that a small amount of damage might be caused in this way, but it is not likely that it would be very great, certainly not enough to materially affect the issue of a war. Wanton destruction of private property has often been tried in warfare, but the effect has usually only been to embitter the struggles. There are, however, other and more legitimate ways in which the command of the air may probably be the deciding factor in a war. The first of these is the facility it gives for ascertaining an enemy's disposition and movements. This is of the utmost importance in war, and there is no doubt that a very large army might easily be completely paralyzed by a very much smaller one if the latter could always ascertain the enemy's movements without revealing its own. In fact, in many cases the amount of superiority which the force without flying machines would require from this cause alone would be overpowering. The position would in fact be the same as that of a blind man boxing against a man who could see. Besides getting information as to an enemy's movements, flying machines may be of enormous use in war by acting on an enemy's communications. A modern army, especially of large size, is absolutely dependent on its communications for everything that makes it of any use as a fighting force. The amount of food alone which is required is very large, and of course, without this the army cannot live, let alone fight. But besides food, huge supplies of ammunition and stores of every kind are required. The expenditure of these gets greater every year, as the material of war gets more complicated, the rate of fire greater, and the expenditure of every kind more lavish, and without a steady stream of supplies pouring into it an army is helpless. Even in the American civil war the Northern armies were often very much hampered by the raids of the Southern cavalry, who destroyed the railways, bridges, roads, etc., on which their supplies depended. The amount of damage which could be effected by cavalry would, however, be nothing to what could be done by flying machines, owing to the superior speed of the latter, the fact that they can move over any sort of country, and that probably much larger weights can be carried than could be on a horse. No doubt if communications were short they could be protected by leaving enough men on them, but this means (1) that the army could never move far from its base; (2) that a very small proportion of the total army could be at the front. There would probably be many minor ways in which flying machines could also cause inconvenience and loss to an enemy.

One point of great importance is that the use of flying machines will render the command of the sea of much greater importance than it has hitherto been. So far command of the sea has given no direct power of attack on land, except the power of subjecting a very narrow strip of coast to gunfire. This is practically useless, and so the direct power of attack on land is nil. It is true that command of the sea has often decided a war by interfering with trade and so bringing about exhaustion, and this result is accentuated by the fact that such command gives the power to land troops at any point without warning, a matter of enormous importance. The use of flying machines in conjunction with command of the sea will, however, increase the striking distance by the amount of the radius of action of the flying machine. There is no reason why the latter should not in the future start from a ship as well as on land, and therefore the fleet would form their base of operations. Thus supposing that the flying machines were capable of flying 300 miles, it is obvious that they would have a striking distance of 150 miles from the coast in any direction, which might be a very serious matter for some nations whose military power is at present very great.

Obviously the way to combat flying machines will be to build opposing flying machines, and the command of the air will have to be fought for as has been the command of the sea. There will be fights in the air consisting of single engagements, and possibly of pitched battles between fleets of airships. What form the future fighting machine of the air will take it is impossible to forecast, and whether the navigable balloon will have any vogue, or whether the aeroplane will be universal, is doubtful. At present it appears as if the latter would be the case, owing to the aeroplane being faster, quicker at turning, harder to hit, and very much cheaper, the latter point always, of course, insuring a numerical superiority with the same money spent on each type of airship.

While it is not possible to see what form the future flying machine will take, we can make some forecast as to what countries are likely to be most successful. The command of the air will depend on (1) the men, (2) the material. Without men of nerve and skill to handle them, flying machines will be useless for fighting or any other purpose. Again, without the flying machines it is obvious that men cannot fly, and are therefore useless for air fighting. The position is in fact exactly the same as that of command of the sea. This has depended on men of cool daring to man the ships, combined with a well-trained, industrious body of civilians at home to supply the ships, ammunition, and other necessary stores. As regards the men, fighting in the air will apparently need essentially the same qualities as are required for navigating and fighting on the sea. But however good the men are, they are quite useless without material. In the case of flying machines, as in the case of ships, this resolves itself simply into a question of money. Those who spend the most money are in the position to get the most numerous and best equipped ships, and will be in the same position as regards flying machines. In the case of war in the air, as at sea, success will depend not only on plenty of material to commence with, but to supply the wastage of war, which is enormous and gets greater and greater as the material gets more complicated and expensive. In all modern wars success depends even more on the civilians at home supplying the fighting force than it does on the actual fighting force itself, but on the sea this is far more the case than on land, and in the air will probably be more so still.

As far as can be seen, therefore, the net result of war in the air will be to very greatly increase the offensive power of those nations which now have command of the sea, and to make the huge continental armies of very much less value than they have been. In fact, the time may not be far distant when no numerical superiority will avail against a small, well-equipped army, commanding the air.—Engineering.

THE INVENTION OF THE SLIDE RULE[1]

Some modern writers attribute the invention of the rectilinear slide rule to Edmund Gunter, others to William Oughtred, but most of them to Edmund Wingate. This disagreement is due mainly to lack of opportunity to consult original sources. It is the purpose of this paper to demonstrate that Wingate never wrote on the slide rule, and that Oughtred is the inventor of the rectilinear as well as the circular type.

It was pointed out by Prof. De Morgan that Gunter invented Gunter's line or scale, but that he did not invent the slide rule. As Gunter's works are found in most large libraries, the correctness of this statement can be readily verified. This scale was not a slide rule, for it had no sliding parts.

No one denies that William Forster published in London in 16[illegible] a book entitled *The Circles of Proportion*, which described the circular slide rule invented by William Oughtred. In the dedication it is said that Oughtred invented also the straight-edge type, but this was not described until 16[illegible]3, when Forster brought out an Addition unto the Use of the Instrument, with an appendix entitled The Declaration of the Two Rulers for Calculation, which described the rectilinear slide rule.

The question remains: Did Wingate invent the straight-edge slide rule, and is he entitled to priority over Oughtred?[2] De Morgan maintained that Wingate never wrote on the slide rule, but he had not seen all of Wingate's books. Thus he admits that he had not examined Wingate's Of Naturall and Artificiall Arithmetique, 16[illegible]0, yet this very book is quoted by several recent writers as describing the slide rule, but these and all writers who name Wingate as the inventor invariably fail to give evidence which would show that they had actually seen the book to which they refer. We have gathered information about all Wingate's mathematical books which De Morgan did not examine. We shall state where copies can be found, so that the data given here can be verified by those who are near the libraries named. We take up Wingate's books one after the other and show that none contains the slide rule.

(1) L'Usage de la Règle de Proportion, Paris, 16[illegible]4. De Morgan's assertion that this book describes nothing more than Gunter's scale[6] is corroborated by L. M. N. Benoit, who examined copies in the Bibliothèque Nationale and the Bibliothèque Mazarine in Paris. There is a copy in the Bodleian Library.

Wingate brought out in 16[illegible] in London a translation under the title Use of the Rule of Proportion. Later editions appeared in 16[illegible]8, 16[illegible], 16[illegible] and 1683. De Morgan saw the 16[illegible] edition, a copy of which is in the British Museum. Wingate died in 16[illegible].

(2) Arithmétique Logarithmique, Paris, 16[illegible]. De Morgan described this book. He saw also the Logarithmetical Table, London, 16[illegible], which is anonymous, but is attributed to Wingate.

(3) Construction and Use of the Line of Proportion, London, 16[illegible]. Copy in the British Museum. The line of proportion here described is merely a mechanical table of logarithms. There are no sliding parts.

(4) Of Naturall and Artificiall Arithmetique, London, 16[illegible]. Copy in the Bodleian Library. Describes only the instrument given in the preceding text. The first part of this book was enlarged by John Kersey the elder in 16[illegible]0 under the new title Arithmetique Made Easie. De Morgan saw the editions of 1673 and 1[illegible]0. The second part was re-edited by Wingate in 16[illegible]. Copy in the British Museum. The instrument described here is still the line of proportion.

(5) Ludus Mathematicus, London, 16[illegible], 1681. De Morgan inspected the first edition.

(6) Use of the Gauge-rod, London, 16[illegible] (second edition).

(7) The Clerks Tutor for Arithmetick and Writing, [illegible] being the Remains of Edmund Wingate, London, 16[illegible]. Copies of both books in the Bodleian Library. Neither contains an account of the slide rule.

The longest masonry span in the world is said to be the Grafton Bridge, now being completed by the city of Auckland, New Zealand. It is 910 feet long and 10 feet wide, and the middle arch has a span of 320 feet and a roadway elevation of 147 feet above the lowest part of the valley which it crosses.

SCIENCE NOTES

It is ridiculous to say nowadays that the study of the humanities consists solely of the study of the writings and philosophy of the ancients; to take that view is to take the view of the schoolmen, the death blow to which was given by Bacon and Bruno. We have got beyond that; we claim that the true study of the humanities is a far wider thing. It is the study of the stupendous mechanism of the universe of which man forms a part, and the understanding of which is necessary for his happiness. That is the true humanity of which the other forms only a small portion. The time is coming when the principal preoccupation of man shall be the gradual disclosure of this mechanism, and his principal delight the contemplation of its beauty.

An interesting discussion aroused by the storm of September 25th has been going on in Nature and elsewhere between Sir Oliver Lodge and Dr. C. Chree. The former claims that the phenomena are consistent with and strongly support the theory that such storms are due to the emission of vast multitudes of electrons from the surface of the sun during a solar eruption, as evidenced by the appearance of spots on the sun. The stream of electrons projected at an immense velocity in the form of a conical beam has a magnetic effect calculated to be equivalent to that of hundreds of millions of amperes, and as the beam passes over or near the earth the magnetic disturbances pass from positive through zero to negative. Dr. Chree points out, however, that the disturbances are not limited to the declination as Sir Oliver appears tacitly to assume, but take place also both in the meridian and in the vertical component of the earth's magnetic force, and the storm does not correspond to a disturbing force in a fixed direction, waxing and waning, but is irregular and oscillatory. Moreover, the average duration of such storms is not 9 hours but 30 hours. Dr. Chree does not combat or support the emission theories, but calls for reservation of judgment and minute study of the records with an unbiased mind.

Trained through long ages to believe that the heavens were the abode of the gods who constantly interfered in the daily affairs of life and in the smallest operation of nature, it seemed to men impious to maintain that the earth was in the heavens, and to peer into the mysteries which surrounded them; and the endeavor to do so has been stoutly resisted, but the conflict, in so far as it has been a conflict with prejudice, is now over. It vanished in the triumph of the modern views on the origin of man which will be forever associated with the names of Lamarck, Spencer and Darwin. The triumph of these views does not mean that they are correct or that we know anything more about the great mystery of life than we did before. He would be a bold and a prejudiced man who made that assertion. What it means is this, that man has grown up, that he has cast off the intellectual tutelage under which he has hitherto existed, that he has attained complete intellectual freedom, and that all things in heaven and earth are legitimate subjects of investigation. But it means even more than this. It means that the conviction is rapidly growing upon him that the only way in which he can hope to improve his condition is by understanding the laws, physical as well as spiritual, under which he exists, and this he is determined to try to do by the only method open to him, that of minute and arduous research.

The Natural History Museum of Paris lately received a specimen of a new type of insectivorous animal coming from the western region of China. This region and also that of Thibet possesses many species of such animals, as Prof. Trouessart states in his paper on the subject presented to the Académie des Sciences, and most of them have been classified since 1870, and nearly double the number of generic forms. The scientist Armand David had discovered these specimens, and it was thought that the list was complete. The present one, however, adds to the number, and it comes from the elevated regions of Moupin and Thibet, being sent to Paris by a missionary, M. Biet. It belongs to the family of porcupines, but does not possess quills, thus resembling the insectivorous animals of this family which are found in the Malay region. What is striking is that the new type resembles in its dentition certain small insectivorous animals which existed in France in the oligocene epoch. The forms of the present animal are considerably different from those of the porcupine. The animal is very light and is adapted for running and jumping like the Macroscelides of Africa. It is a small animal about the size of the mole, with long head and prominent nose in the form of a short trumpet, large ears and a long tail. In this respect it resembles the Podogymnura of the Philippines, recently described by Mearns. Its fur is soft and of a reddish brown, with long black hairs projecting out, these being more abundant on the back. The present species inhabits Ta-tsien-lou in the province of Se-tchouen, at 2,545 meters altitude.

TRADE NOTES AND FORMULÆ.

Preparation for Soles of Boots (Heller and Axler's). To render the soles watertight, saturate and coat them with a mixture of 50 parts of linseed-oil varnish, 10 of water-glass, and 40 of Naxos emery.

Preservatives for Soles (Campe's).—For some years past Campe has saturated old boot and shoe soles with linseed oil varnish, coating new soles four or five times. A slight addition of copal varnish would probably increase the effect.

Pascal's Soup Extract.—Moderately boil vegetables in a double kettle for 6 hours and squeeze off the broth. Put some beef and bones in the latter and boil for 6 hours longer. Again squeeze out the fluid, and when it is cold remove the fat, portions of which should be added again later. Add 30 per cent of salt and boil down the whole till it is of the consistency of syrup.

Spence metal is employed for tightening water pipes and as a substitute for marble and cement. It cannot, however, be used as a substitute for lead plates for sulphuric acid chambers, for it is powerfully acted upon by nitro-sulphuric acid. The composition has a specific gravity of 3.1 to 3.7, and the melted mass hardens at a temperature of 182-183 deg. F., the fluidity changing to viscosity. To prepare the composition, dissolve 1 part of sulphur in a well covered vessel and stir in 2 parts of finely powdered pyrites.

Substitute for Rubber.—Suffuse purified cherry gum, chopped fine and previously washed with water, with three times its weight of water, and let it stand for a time, stirring frequently. Then pour off the clear solution and leave it to dry; a preparation similar to gum arabic will be obtained. Over the undissolved portion pour a liquid made of 10 parts caustic soda, 25 parts sodium carbonate and 100 parts water. Put the mixture in a water bath and heat, with constant stirring, till it is dissolved, then dilute the liquid with water, treat if necessary with animal charcoal, filter and evaporate till the mass is dry, or till the residue can be spread on glass plates, putting the latter in a warm place to dry.

Semi-liquid Belt Dressing.—Dissolve together 6 parts petroline, 21 parts fish oil, 5 parts resin and 2½ parts wool grease, adding 1 part mucilage and afterward 1 part of tallow, stirring the mixture. Now pour the mass into suitable vessels and keep on stirring till it gets cold. Belt dressing in sticks is compounded in the same way, but with the addition of 10 parts resin and 7 parts ceresine. The sheet metal cases used for molds, provided with a stopper at one end, should be placed in a tub filled with water, and the mass poured into them. When the mass is cold the stopper is removed from the case and the stick, now finished, forced out by pressure. The sticks are then wrapped in tin foil and packed in labeled cardboard boxes.

To Render Photographs Transparent.—Heat 10 parts (grammes) of paraffin and 10 parts (cubic centimeters) of linseed oil till the mixture begins to melt, and dip the picture in it. Then place the picture between layers of blotting paper under pressure to remove any excess of the solution. Photographs treated in this way can be attached to glass by means of 100 parts (cubic centimeters) of a syndeticon (liquid fish glue) and 26 parts (grammes) of sugar. There are various kinds of paraffin having different melting points, ranging between 86 deg. F. and 140 deg. F. It is well, therefore, in order to obviate superfluous heat, to heat carefully and only till the paraffin dissolves and combines thoroughly with the linseed oil.

Waterproof Paint.—5,000 parts of chalk and 1,000 parts of zinc white steeped in 3,000 parts of water, to which 50 parts of alum have been added, mix with a glue solution of 750 parts of glue in 2,000 parts of water, constitute the body color. Coloring: Earth or metallic colors mixed with water. To the mixture add 2,000 to 2,500 parts of varnish and 7,500 parts of linseed oil boiled with 330 parts of pale rosin, 330 parts of litharge, 50 parts of red lead, and 50 parts of umber, gradually adding 230 parts of zinc vitriol; finally add a solution of 350 parts of caustic potash and 350 parts of alum in 15,000 parts of water. After evaporation of a portion of the water, allow it to cool. After mixing with the priming, add 5 per cent of the weight in petroleum.

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[1] Abstract of a paper read by Prof. F. Cajori before the Section of Mathematics and Physics, [illegible] British Association, Winnipeg, August [illegible].

[2] [illegible] Cajori, History of the Logarithmic Slide Rule (New York, Engineering News Publishing Co., 1909).

[3] Penny Cycl., Art. Slide Rule, and Wingate, Edmund; Arithm. Books, [illegible] (London, 1847).

[4] Arithm. Books, p. [illegible]

[5] A. Favaro in [illegible] Atti (5) [illegible] 1878, p. 500; Mehmke in Encyklop. d. Math. Wiss., vol. I, [illegible] (Leipzig, 1898-1904).

[6] Arithm. Books, p. 4[illegible]

[7] La Règle à Calcul expliquée, p. [illegible] (Paris, 1853).

Penny Cycl., Art. Tables, p. 407.

[9] Loc. cit., p. 408.

[10] Arithm. Books, pp. 48, 73.

[11] Op. cit., p. 44.

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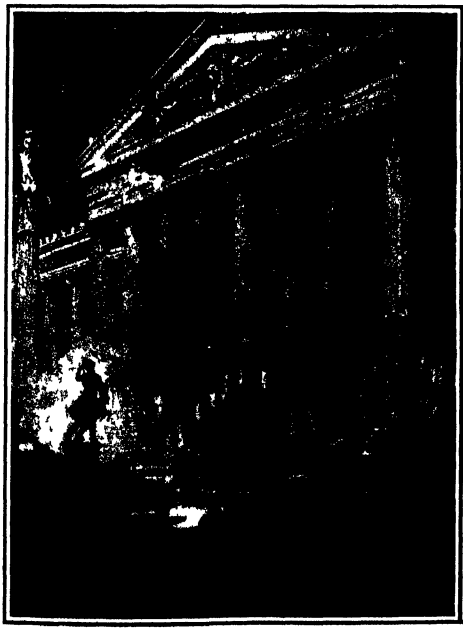
THE PHAROS OF ALEXANDRIA

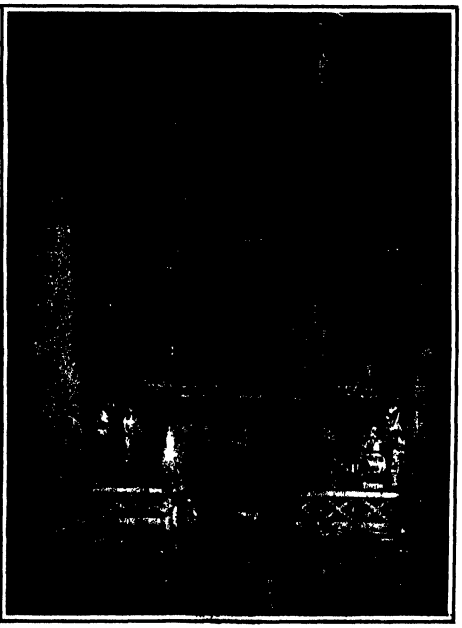
THE COLOSSUS OF RHODES



By courtesy of the Sphere

PROCESSION PASSING DOWN THE STEPS OF THE GREAT TEMPLE OF DIANA

The Temple of Diana had a magnificent pillared frontage and was a treasure house of Greek art.



From painting by Kupka

WORSHIPERS BENEATH THE GREAT STATUE OF JUPITER AT OLYMPIA

The statue was the work of the Greek sculptor Phidias.

THE SEVEN WONDERS OF THE WORLD [SEE PAGE 120.]

THE CHINESE CALENDAR.

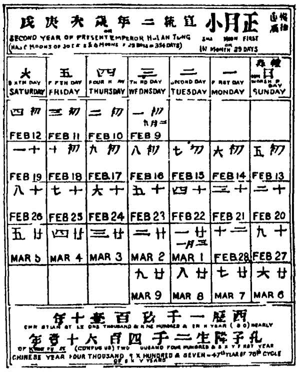
HOW THE CHINESE ARRANGE THE YEARS AND MONTHS.

BY DANIEL ARTHUR.

Good fortune, long life and happiness to the Chinese. Their new year day has begun. It will be the year [illegible] of the present Emperor Hsuan Tung. It will also be the [illegible] year of the great man Kung Fu Tze (a name we have Latinized into Confucius). It is also the year 460[illegible] from the beginning of the reign of the Yellow Emperor Hwang Ti, and as the sexagenary system was started on the 60th year of his reign by Nao the Great (then prime minister) it makes the coming Chinese year [illegible] on the [illegible]th year of the [illegible]th cycle of 60 years. Some American almanacs make the mistake of assuming that the [illegible]th cycle is completed and that the Chinese have entered the next to the extent of [illegible] years. That is to say, they multiply it by 60 and add [illegible], while they should make it thus: [illegible] cycles of 60 completed plus [illegible], which is the distance entered into the [illegible]th [illegible] 60 [illegible] 4 [illegible]. The conflict may have come about in the assumption that the sexagenary system began with the reign of Whang Ti [illegible] B. C. instead of at the 60th year of his reign [illegible] B. C. But in that event we would have to say that the coming Chinese year was the [illegible]th of the 7[illegible]th cycle. It is quite well established, however, that the cycle system began in the year [illegible]7 B. C. Add to this our A. D. date 1910 = [illegible]47. This also fits the contention that the current cycle runs from 18[illegible] [illegible].

When we go a few thousands of years into B. C. history of China we find the rulers living to the age of hundreds of years. When I jokingly asked my friend in the Chinese consul's office in New York if it might be possible that these were short-weight years, he strenuously said no, no, that these Chinese gentlemen knew how to live. Our jolly Chinese scholar and diplomat Wu Ting Fang said he would pay America another visit in 19[illegible]. This will be the year of the Boar Ki Hai, or the [illegible]th year of the 77th cycle.

On Tuesday night of this month of February, as twelve struck on New York bells, the arrival of Wednesday the 9th was announced, and with it the new year day of the first installment of United States Chinamen. Very few of the Chinamen living in our Eastern time zone, which includes the capital at Washington in its zigzag boundary line, realized that they were ushering in the new year some twelve hours before it arrived in their home country, while they should have been about twelve hours after China. American almanacs quite properly say that Chinese new year day is February 10th. The Chinese merchants and bankers of the United States still continue to make this curious mistake, which began in a very simple way. The Chinamen coming east across the Pacific against the sun arrived with their almanacs and calendars at San Francisco and then journeyed across the continent to New York. Other Chinamen left China and traveled across Europe with the sun and then to New York via the Atlantic, also bringing their unaltered calendar with them. A date line did not happen to be worth while noticing by either of these streams of travelers, so when they compared notes at New York the men coming off the Atlantic steamers declared that those coming *via* San Francisco had made a mistake in the count and number of their days, that they had jumped a day ahead. The others charged that the Atlantic travelers had slept through two nights somewhere without knowing it and had therefore lost a day, so to speak. Both sets of men were as much right as they were wrong, but neither of them had recognized a date line in any part of the world. There is no special place where a date line should be, other than that it should be stuck in some out-of-the-way place where busy or forgetful people would not be bothered with it. That is why it was put where it is, at the 180th meridian, with a few deflections for local convenience, or, as the Dublin wit said, if the Astronomer Royal at Greenwich put the line any farther from home it would get nearer. As more Chinamen came to America *via* the Pacific than the other way, the larger party unconsciously forced the minority to set the date line in the Atlantic, where it has since stayed without even being known to any but a few Chinamen. It would of course be far better for China to use the international date line, and in a certain sense she does so in a semi-official way now. But it would be a great convenience to Chinamen both at home and abroad if Emperor Hsuan Tung would issue an edict through the Chinese Legation at Washington that all Chinese-American calendar printers recognize the now established Pacific line and therefore follow the home country in its gala days and dragon feasts instead of anticipating them by a day in an indefinite way. I am informed by the Hydrographic Office of the United States Navy Department that China has now officially inaugurated or copied our 1[illegible]-deg. hourly zone system in China. This will of course be slow to reach local merchants in China, but as that country is 60 deg. or four hours wide, her railroads running east and west will soon see the advantage of the hour zone system.



正月小 宣統二年歲次庚戌

SECOND YEAR OF PRESENT EMPEROR HSUAN TUNG (HAS [illegible] MOONS OF 30 [illegible] & 6 MOONS OF 29 DAYS = 354 DAYS)

SMALL MOON FIRST OR IN MONTH 29 DAYS

六 SIXTH DAY SATURDAY	五 FIFTH DAY FRIDAY	四 FOURTH DAY THURSDAY	三 THIRD DAY WEDNESDAY	二 SECOND DAY TUESDAY	一 FIRST DAY MONDAY	禮拜日 WORSHIP DAY SUNDAY
初四 FEB 12	初三 FEB 11	初二 FEB 10	初一 二月九 FEB 9			
十一 FEB 19	初十 FEB 18	初九 FEB 17	初八 FEB 16	初七 FEB 15	初六 FEB 14	初五 FEB 13
十八 FEB 26	十七 FEB 25	十六 FEB 24	十五 FEB 23	十四 FEB 22	十三 FEB 21	十二 FEB 20
廿五 MAR 5	廿四 MAR 4	廿三 MAR 3	廿二 MAR 2	廿一 三月一 MAR 1	二十 FEB 28	十九 FEB 27
			廿九 MAR 9	廿八 MAR 8	廿七 MAR 7	廿六 MAR 6

西歷一千玖百壹十年

CHRISTIAN STYLE ONE THOUSAND & NINE HUNDRED & TEN YEAR (1910) NEARLY

孔子降生二千四百六十壹年

OF KUNG FU TZE (CONFUCIUS) TWO THOUSAND FOUR HUNDRED & SIXTY FIRST YEAR

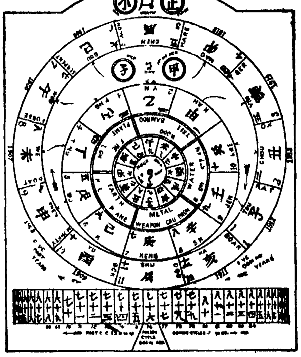
CHINESE YEAR FOUR THOUSAND SIX HUNDRED & SEVEN = 47TH YEAR OF 76TH CYCLE OF SIXTY YEARS

THE FIRST MONTH OF THE CHINESE NEW YEAR

Now for a word on the accompanying illustrations. The square one is the first sheet or month of the above mentioned new year, and the long cut is a complete sexagenary cycle with translations. We will take up the first month of the Chinese year and later speak of the curious formation of the cycle.

In the upper right hand corner of the calendar sheet you will notice four characters. They mean read toward left and downward. The three larger ones to the left translate into first moon small, or first month 29 days. Almost all eastern calendars are lunar ones, that is to say, are based on moons or lunations. As this unit is approximately 29½ days, the Chinese consistently make their months 29 days and 30 days (none of 28 or 31 days). Their month always begins and ends when the moon is between the sun and the earth (the dark or new moon). Their year begins and ends the same way. That is to say, new year day is a new moon, and so of course must be the last day of the year. As there are 31 of these new moons in about 2½ equinoctial years, or say about 62 of them in five years, China must get them all in to keep her seasons from making complete rotations. China bases her year on a twelve month or twelve moon plan. The added or intercalary units are whole months, one of which she must add every 30 months, or let us say twice in every five years. This means that two years out of every five years contain 13 months, or say 383 or 384 days, the other three years being 12 months long, consisting of say 354 days. Although the 29 and 30 day month is planned to keep seasons correct so far as long periods are concerned, it will readily be seen that within these five year cycles seasons go wrong more than a month. This leads to the necessity of having a set of planting, reaping, fishing and hunting instructions for every year, which partly accounts for the numerous pages in the Chinese almanac. This curious book, *which has no advertisements and is said to* have the largest circulation or sale of any book in the world, shows that the closing year, the year of the bird or chicken or rooster or cock, had 13 months, consisting of a first month, a true second month, an intercalary second month. Then come the third, fourth, fifth and so on up to the twelfth and last month, which is really the thirteenth. This year contained 383 days and began in America January 21st, 1909, and will end February 8th, 1910. But to come back to the calendar month, the eight characters other than the ones above mentioned mean second year of the present Emperor Hsuan Tung. At the bottom of the cut the line of 9 means Christian style 1910 nearly. The lower set of 12 characters reading toward the left mean Confucius year 2461. This great man's family name was Kung and his given name Tze. We would read it Mr. Tze Kung. China gave him a sort of honorary title called Fu in Chinese, so he became Kung Fu Tze as his countrymen knew him. We have latinized this whole proceeding into Confucius.

The top rows of squares show the days of the week, beginning with special sun worship day, followed by first to sixth days, Monday to Saturday. Why seven days? Some say because these were seven original stars to the Chinese. Others point out to us that China has 28 stellar mansions numbered 1 to 28, and that the 4th, 11th, 18th and 25th of these were halting places for the sun, and correspond with our western Sundays. They were also observed in ancient China as days of rest for men as well as for the sun. Now we come to the squares for dates, beginning with the first day (Chinese new year day) being a single horizontal line or dash, in front of which (to the right) is a fancy character which can be freely translated into day, meaning day 1, day 2, day 3 being 1 dash, 2 dashes and 3 dashes. Then comes the box shaped character 4, the digits can be followed up to 10, which consists of a cross like a plus sign. This is the last numeral which has to be preceded with the character day, it being assumed after that. For 11 we have a cross and a dash meaning 10 and 1 = 11, followed by 12, a cross and 2 dashes. By following this plan we arrive at 19, consisting of the cross and the Chinese digit 9. Thus we have reached 20, which is just the reverse of the Chinese 12, that is to say, we find two dashes followed by the cross. This means 2 times 10 = 20. When a small number precedes a large one, it is always a multiplier, but when it follows the larger number it is always added. Twenty-one usually consists of this same combination followed by a single dash, making it read 2 times 10 and 1 = 21. For convenience, however, a condensed form of 20 to be used from 21 to 29 has been devised, so that these numbers can be constructed with two characters instead of three. This abbreviated 20 consists of two vertical strokes with a horizontal dash across them at the middle and a small link at the bottom. This condensed form followed by Chinese digits 1 to 9 carries us up to 29. This number brings us up as far as the end of Chinese months, but as we will refer shortly to the 76th cycle of 60 years, it might be well to describe these numbers up to a higher figure. Thirty is three dashes followed by cross = 3 × 10. Thirty-one is a condensed form of 30, the same as 20 with an extra vertical stroke. This character followed by the digits 1 to 9 brings us from 31 to 39. Forty is square digit 4 followed by crosses 10 = 4 × 10. Now for 41 to 49 we are not permitted to use a condensed 40. Hence these numbers require three characters, consisting of digit 4 followed by cross 10, and these two followed by the digits 1 to 9. This formula is carried up unchanged to 99, when a special character comes in for 100, which when qualified by the digits and followed by numbers 1 to 99 brings us up in regular order to 999. A character for 1 000 is then brought in. By preceding it with the digits as multipliers followed by any



A CHINESE CALENDAR CLOCK

of the combinations below 1 000, it becomes just as easy to write a Chinese number up to 9 999 as it is to write it in Arabic and very much easier than the Roman numerals Before leaving the subject of Chinese numbers it should be said that it is just as permissible to write a Chinese number in a vertical line as in a horizontal one but it must always be constructed and read from top down or from right to left That is to say the Chinese number 51 is the Chinese digit 5 followed by 10 and then 1 written down or toward the left In either case it means 5 × 10 + 1

Refer now to the 76th cycle the long narrow cut In the first column (the right hand one) are arabic numbers for the 60 years of this cycle In the next column are Chinese equivalents which the reader can now write as easily as ours The next two columns are the 10 stems and 12 branches sometimes called the 10 celestial stems and 12 honorary branches or the 10 mothers and 12 children In older China the affinities of the 10 stems meant the 5 original elements of the universe—earth metal water wood and fire and many other things too numerous to mention here The 12 branches or 12 honorary characters or 12 children meant the 12 parts of a man, the 12 signs of the zodiac, the twelve great men the 12 parts of a day (six for light and six for dark) the 12 months of the year the 12 animals There were also cycles of years based on this duodecimal plan which were given the names of animals as follows

Rat or Mouse	Ox or Bull	Tiger	Hare or Rabbit	Dragon	Serpent or Snake
Horse	Goat or Sheep	Monkey or Ape	Cock Chicken Rooster or Bird	Dog	Boar or Hog

These animal names become synonymous with numbers Hence a Chinaman or a Japanese will tell you he was born in dragon year or dog year Clocks are still running which strike the hour of the rat or the horse Expressions such as before horse or after horse meaning before noon or after noon or A M and P M are in use Full horse was exact noon In modern China however these signs of the stems and branches or mother and children have come to mean numbers only 1 to 10 and 1 to 12 They still retain one syllable names the approximate sound of which is given in the two columns You will notice that it takes six sets of stems to make a column of 60 and five sets of branches and as these five and six sets overlap each other on a sort of slide rule plan no stem or branch meets more than once on the horizontal lines This makes sixty different combinations or pairs of stem and branch characters, thus forming 60 two syllable words no two of which are alike Thus the first year of this or any other sexagenary cycle of sixty becomes Kiah Tsu, the 46th of the cycle just coming to a close is Ki Yu The new year the 47th becomes Keng Suh The last syllable of it means dog Hence the new year will be dog year' on the cycle of 12 plan

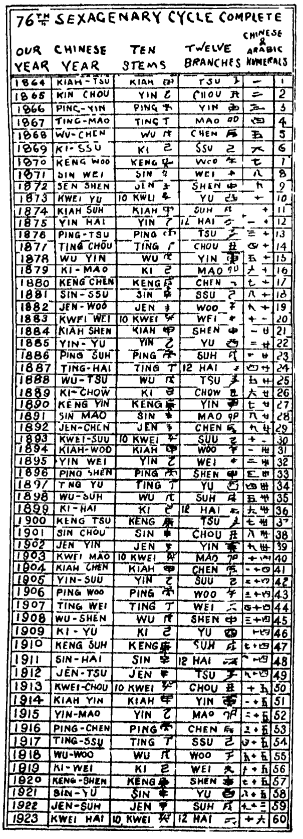
The reader may get the impression that the Chinese calendar is so bad that it could hardly be worse This is perhaps partly true but what answer could we give an educated Chinaman if he asked us why we adopted his ancient seven days for a week or still use his months in their sadly confused form of 28 29 30 and 31 days in such an irregular order that we have to memorize a silly rhyme to know how many days are in a certain month? We could of course point with pride to the fact that Pope Gregory gave us a year which does not go wrong over a month as the lunar one does but less than a day

The Chinese or Japanese calendar clock shown is drawn from fragmentary information and such odd parts as have come to the writer's notice The hour day month year and cycle are set to indicate the Chinese New Year as above mentioned The small bent hand or pointer in the center indicates the hour of the rat (2 hours long) the center of which unit corresponds with our midnight There are many interesting points regarding the clock proper that I would like to speak of here, but as the subject is calendars we will not depart now The day begins and ends when the hand is at the bottom on this clock Therefore we will assume that the last day of the 46th year of the 76th cycle has just departed and that the first day of the first month of the 47th year is moved into proper position We look for the two small circles marked "1st month" and '1st child' giving us the double syllable name or number of the 1st day Then at the top the two circles on either side of the month character we show movable characters meaning first and small That is to say this particular month has 29 days The large ring containing the 12 branches has then moved one space, bringing the New Year animal name Shu into proper place at the bottom to read 'Dog year to those using the separate cycle of 12 But this large ring is an internal gear of 12 teeth or any multiple of 12 travelling in unison with another ring which carries the 10 stems but with teeth on its outer edge in the ratio of 10 to 12 as compared with the internal gear Therefore it takes six complete rotations of the stems to each five complete ones of the branches It also follows that as the stem ring has made 4 rotations and 7 spaces it reads 4 × 10 + 7 47th year or as the large ring of branches has gone three times around and 11 spaces it reads 3 × 12 + 11 = 47 again This brings the 7th stem Keng directly over the 11th branch Shu and with these two single syllables made into a two syllable word we have again [illegible] or Keng Shu the present year

The five pairs of stems and branches which are breaking company on the left show the past five years and double headed arrows indicate how these stems and branches change partners to mark the five coming years The Chinese numeral on the left top corner of each space indicates the numeric equivalent of each stem and branch when they are used separately They are geared together here however to get the sexagenary period No odd and even branch or stem ever coincide but always even and even or odd and odd In other words the top stem always jumps over the top branch to select its new partner When these 10 stems and 12 branches complete their 60 different partnerships the 76th cycle of 60 years will be complete Then the horizontal wheel at bottom will move to the next cycle bringing the Chinese number 77 on the center line or as it reads by literal translation 7 times 10 and 7 This same order will continue up to the 120th cycle or 2 × 60 × 60 = 7 200 years from the beginning of this system This whole proceeding of course depends on keeping the machine going and attending to the intercalary connections to keep seasons from rotating To repeat let us say that this calendar reads as it now appears in the illustration *1st Hour of 1st Day of 1st month of 29 days of the 47th year of the 76th cycle of years* which is also the 2461st of Confucius or second year of Emperor Hsuan Tung or the 4[illegible]th year by the sexagenary system or 4607 from the time the Yellow Emperor Hwang Ti ascended the throne It is also most nearly associated with our year 1910

Refer to the annular space between the clock dial and stem ring This space has five spokes which divide the world into the five original elements (as the Chinese supposed) Earth Metal Water Wood and Fire The affinities or extremes of earth are *Wu* a hill or mountain and *Ki* a level field or plain Metal extremes are *Keng* an implement of war and *Sin* a cauldron an implement of peace Water was of two kinds rough billows or waves and placid streams They are *Jen* and *Kwei* Wood consisted of *Kiah* a heavy tree and *Yin* light bamboo Fire was made up of *Ping* a sort of flame and *Ting* meaning light These ten stems are the result of the *Yang* and *Yin* or positive and negative or extremes of the five elements

The twelve stems are frequently used as the 120 minute hours of Japan No 1 or Rat is midnight (after 60 minutes of it are used) The sixth stem or Horse therefore becomes noon but not till the middle has been reached That is to say the first half of Horse is still forenoon the latter half is afternoon and the exact middle is full horse or true horse meaning exact noon When these 12 stems are used under the proper radical to represent the stars Rat becomes Taurus and Horse Scorpio When we come to the twenty eight stellar mansions however the stems and branches are laid aside for twenty eight characters which Dr Carus in his Chinese Thought supposes to be an ancient form of the lunation before it was properly measured I am more inclined to think that it was a sidereal lunation taken on the broad view of the universe making a year of 1[illegible] day months or 364 days and requiring only one intercalary day and two every fourth year



OUR YEAR	CHINESE YEAR	TEN STEMS	TWELVE BRANCHES	CHINESE & ARABIC NUMERALS	
1864	KIAH-TSU	KIAH 甲	TSU 子	一	1
1865	KIN CHOU	YIN 乙	CHOU 丑	二	2
1866	PING-YIN	PING 丙	YIN 寅	三	3
1867	TING-MAO	TING 丁	MAO 卯	四	4
1868	WU-CHEN	WU 戊	CHEN 辰	五	5
1869	KI-SSU	KI 己	SSU 巳	六	6
1870	KENG WOO	KENG 庚	WOO 午	七	7
1871	SIN WEI	SIN 辛	WEI 未	八	8
1872	SEN SHEN	JEN 壬	SHEN 申	九	9
1873	KWEI YU	10 KWEI 癸	YU 酉	十	10
1874	KIAH SUH	KIAH 甲	SUH 戌	十	11
1875	YIN HAI	YIN 乙	12 HAI 亥	二十	12
1876	PING-TSU	PING 丙	TSU 子	三十	13
1877	TING CHOU	TING 丁	CHOU 丑	四十	14
1878	WU YIN	WU 戊	YIN 寅	五十	15
1879	KI-MAO	KI 己	MAO 卯	六十	16
1880	KENG CHEN	KENG 庚	CHEN 辰	七十	17
1881	SIN-SSU	SIN 辛	SSU 巳	八十	18
1882	JEN-WOO	JEN 壬	WOO 午	九十	19
1883	KWFI WEI	10 KWEI 癸	WFI 未	十二	20
1884	KIAH SHEN	KIAH 甲	SHEN 申	一廿	21
1885	YIN-YU	YIN 乙	YU 酉	二廿	22
1886	PING SUH	PING 丙	SUH 戌	三廿	23
1887	TING-HAI	TING 丁	12 HAI 亥	四廿	24
1888	WU-TSU	WU 戊	TSU 子	五廿	25
1889	KI-CHOW	KI 己	CHOW 丑	六廿	26
1890	KENG YIN	KENG 庚	YIN 寅	七廿	27
1891	SIN MAO	SIN 辛	MAO 卯	八廿	28
1892	JEN-CHEN	JEN 壬	CHEN 辰	九廿	29
1893	KWEI-SUU	10 KWEI 癸	SUU 巳	十三	30
1894	KIAH-WOO	KIAH 甲	WOO 午	一卅	31
1895	YIN WEI	YIN 乙	WEI 未	二卅	32
1896	PING SHEN	PING 丙	SHEN 申	三卅	33
1897	TNG YU	TING 丁	YU 酉	四卅	34
1898	WU-SUH	WU 戊	SUH 戌	五卅	35
1899	KI-HAI	KI 己	12 HAI 亥	六卅	36
1900	KENG TSU	KENG 庚	TSU 子	七卅	37
1901	SIN CHOU	SIN 辛	CHOU 丑	八卅	38
1902	JEN YIN	JEN 壬	YIN 寅	九卅	39
1903	KWEI MAO	10 KWEI 癸	MAO 卯	十四	40
1904	KIAH CHEN	KIAH 甲	CHEN 辰	一十四	41
1905	YIN-SUU	YIN 乙	SUU 巳	二十四	42
1906	PING WOO	PING 丙	WOO 午	三十四	43
1907	TING WEI	TING 丁	WEI 未	四十四	44
1908	WU-SHEN	WU 戊	SHEN 申	三十四	45
1909	KI-YU	KI 己	YU 酉	六十四	46
1910	KENG SUH	KENG 庚	SUH 戌	七十四	47
1911	SIN-HAI	SIN 辛	12 HAI 亥	八十四	48
1912	JEN-TSU	JEN 壬	TSU 子	九十四	49
1913	KWEI-CHOU	10 KWEI 癸	CHOU 丑	十五	50
1914	KIAH YIN	KIAH 甲	YIN 寅	一十五	51
1915	YIN-MAO	YIN 乙	MAO 卯	二十五	52
1916	PING-CHEN	PING 丙	CHEN 辰	三十五	53
1917	TING-SSU	TING 丁	SSU 巳	四十五	54
1918	WU-WOO	WU 戊	WOO 午	五十五	55
1919	KI-WEI	KI 己	WEI 未	六十五	56
1920	KENG-SHEN	KENG 庚	SHEN 申	七十五	57
1921	SIN-YU	SIN 辛	YU 酉	八十五	58
1922	JEN-SUH	JEN 壬	SUH 戌	九十五	59
1923	KWEI HAI	10 KWEI 癸	12 HAI 亥	十六	60

COMPLETE SEXAGENARY CYCLE WITH TRANSLATIONS

WHAT IS GENETICS?

We are constantly confronted with questions in which we have to think not only of the advantage and happiness of those alive at the present moment but also of those not yet born who will succeed us on the earth The decision of these questions is one of the most important and burning subjects which can be put before us They often crop up in legislation and yet we are quite unable to answer them because of the very little knowledge we possess of the laws which govern the transmission of characters from generation to generation

The interests of future generation often appear to be in conflict with the immediate pleasure and happiness of the living and we are confronted with the question whether we ought to give way to our own humane and benevolent feelings or whether we ought to set our teeth and deal ruthlessly with a number of people who must appeal to our pity lest by saving them from elimination we should bring about an increase in the number of people who are unable to hold their own and so weaken the nation and increase for the next generation the difficulties which we set out to cure We do not pronounce any judgment on these questions we merely wish to emphasize the immense the transcendent importance from the human point of view of the investigations which the study of the question of evolution has caused biologists to carry out into that most difficult of all subjects heredity and of obtaining clear ideas upon the subject These are elementary examples and they might be largely added to from other branches of zoology such as entomology marine fauna and physiology Yet the great practical achievements which have followed from the recognition of the fact possibly appreciated in some ancient civilizations but in modern times first understood by Bacon and his compeers that natural phenomena are in themselves and without relation to immediate utility proper subjects of man's inquiry and that all progress must be based on their thorough and accurate investigation

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A consideration of the mechanical principles involved in valve construction and the duty required lead to the conclusion says a contemporary that electrically operated stop valves offer many advantages as compared with the hand operated type They can be operated from any point often permit a simpler laying out of piping and in time of accident make it possible to shut off a valve that might otherwise be inaccessible on account of fire escape of steam etc The stopping and starting of large units upon short notice is expedited by motor driven valves for the large exhaust piping and when installed between the boilers and steam header or the header and the engine and between sections of the header they enable any break in the piping to be isolated at once or any other trouble checked by closing switches which may be situated a safe distance away from the piping

INSECT PESTS IN AGRICULTURE.

THEIR PRACTICAL UTILIZATION.

The ill repute which attaches to insects in general is justified by the ravages committed by the many insect enemies of flowers, vegetables, grain, fruit and forest trees. These marauders, however, are themselves the prey of various carnivorous and parasitic insects. This civil war in the insect world results to man's advantage, for the insect carnivores are both numerous and prolific. Their methods of attack vary with the species. Some, like the ladybird, simply capture and devour their prey, while others lay their eggs in or upon the larvæ and eggs of their victims.

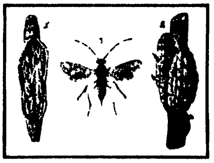


Fig. 1.—1. Larva of Cabbage Moth Opened to Show Parasitic Larvæ of Ichneumon Fly. 2. Full-grown Parasitic Larvæ Emerging from the Skin of their Dead Host and Spinning Cocoons Beside It. 3. Ichneumon Fly. (Greatly Magnified.)

Tetrastichus, for example, pierces the eggs of the elm gall insect and prevents their hatching, and some ichneumon flies deposit their eggs in the bodies of caterpillars which are eaten alive by the larvæ which issue from those eggs.

For the purpose of destroying injurious insects the infested plants, branches, leaves or fruit are often destroyed also. Paul Marchal, an eminent authority on this subject and director of the French institute for combating injurious insects, has pointed out that by this practice we also destroy our natural allies, the insect parasites. For example, farmers have been advised to remove the stubble from grain fields in order to destroy the gall fly (*Cecidomyia*), but the flies have disappeared long before harvest time, while the stubble may still contain parasites which would have attacked the flies of the next season. A similar example is afforded by *Diplosis*, an insect which lives in the grain kernel. Kieffer has proved that the practice of burning the threshed straw defeats its own object, for the pupæ normally lie buried in the earth and only pupæ that have been injured by parasites remain in the straw. Burning the straw therefore merely destroys the enemies of the injurious insect. Decaux, having observed many ichneumon flies emerging from buds of apple branches which had been singed to destroy the apple moth, suggested keeping the buds in covered vessels until all the ichneumon flies should come out. In this way he secured and released from [illegible] barrels of singed buds about [illegible]0,000 ichneumon flies, and incidentally destroyed more than 1,000 apple moths. Berlese kept larvæ of *Cochylis* with their parasites through the pupal stage in boxes provided with openings large enough to permit the parasites to escape, but too small to be traversed by the *Cochylis* butterflies. In the war against the destructive San José scale and other species of *Aspidiotus* it is customary to cut off the infested branches in winter. No other measures are required, for as the scale insects feed only on living plants and are incapable of motion, they starve on the cut branches, while the parasites which feed upon them fly back to the orchard after pupation. The utilization of entomophagous or insectivorous insects is little practised in Europe, but in America, where the subject has been far more thoroughly studied, parasites have been imported from the native countries of plants infested with injurious insects.

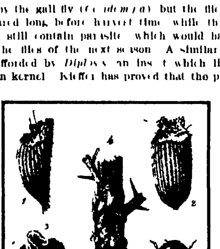


Fig. 2.—1 and 2. Scale Insects (*Icerya*). 3. Scale Insect with Parasitic Larvæ of Novius. 4. Novius Depositing Eggs on Scale Insects. Novius. (Magnified.)

A remarkable instance is that of a scale insect introduced from Australia which nearly destroyed the orange and lemon plantations of California. A commission was sent to Australia to search for parasites of this scale insect. A parasite was found and 100 specimens were brought to California, where they multiplied so rapidly that in the following year 10,000 parasites were distributed among the nurseries, and in a year and a half the scale was almost annihilated and the plantations were saved.

In employing parasites for the destruction of injurious insects the method of procedure necessarily varies with the species which is the object of attack. In America, for the purpose of combating the Liparid moths which are so destructive of fruit and forest trees, hundreds of thousands of nests of caterpillars of *Liparis chrysorrhœa* are sent each winter to a laboratory in Boston, which is devoted to the propagation and study of parasites of moths. The parasites are reared in boxes provided with glass windows through which the life processes and habits of the insects can be observed, and glass tubes, with their outer ends plugged with cotton, are inserted in openings in one side of the box (Fig. 5). The parasitic insects after pupation seek the light and fly into the glass tubes, where they can be examined with a magnifying glass. These parasitic insects are sometimes found to be infested with parasites of their own. In this case the insects and their parasites, or the latter alone, are destroyed. The insects which are free from parasites are set at liberty or kept for breeding. In order to prevent the dissemination of the non-indigenous hyperparasites which occasionally accompany parasitic insects sent from foreign countries, the rooms are kept carefully closed and are provided with double doors. When the useful parasitic insects leave the breeding cages they are usually not set completely at liberty, but are confined either in large cages of fine wire gauze built around and over trees which are greatly infested by injurious insects, or in smaller cages constructed over shrubs, where each parasite species can be propagated separately. In this way the development and increase of each species can be observed, as in the study of bacteria by means of pure cultures.

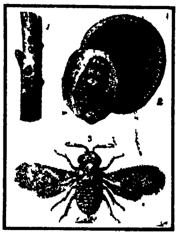


Fig. 3.—1. Twig Infested with Scale Insect (Aspidiotus). 2. Aspidiotus Separated from Its Scale and Pupa of Its Parasite Aphelinus. 3. Aphelinus. (Greatly Magnified.)

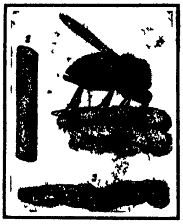


Fig. 4.—1. The Parasite Encyrtus and Egg Clusters of Spinner Moth. 2. The Parasite Depositing Its Eggs in Those of the Spinner Moth. 3. Larva of Spinner Moth Containing Eggs of Parasite.

German entomologists have not quite reached the American standpoint. Prof. Eckstein, for example, writes: "The usefulness of parasites is confined to maintaining the general balance in nature. They have no economical value, for they do not abandon their hosts until the latter have reached the pupa stage, after eating their fill, and the larvæ which escape the parasites suffice for the propagation of the injurious species."—Umschau.

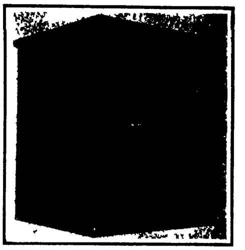


Fig. 5.—Breeding Cage for Parasitic Insects.

FLAME AND OZONE.

Those who are familiar with test-tube experiments in the chemical laboratory may have observed that when a tube containing cold water is placed in the flame of the Bunsen burner, or, better still, in the fierce flame of the Kern burner, a smell strongly resembling ozone is noticeable when the tube is removed quickly from the flame. When the liquid gets warm the phenomenon ceases. The subject has been studied more recently with the view of obtaining definite results, and there appears to be little doubt that ozone is invariably present in flames. In the case of the hydrogen flame the presence of ozone is proved by the action of the flame on silver. A vigorous current of hydrogen is ignited at a narrow jet and only the point of the flame is used to touch the silver. A black film of oxide is produced, which is most intense where the silver is in contact with the hottest zone of the flame. Ozone is not found outside the flame for the simple reason that it breaks down in its passage through the zones of relatively low temperature. Therefore, from a practical point of view, intense flames would hardly serve the purpose of producing ozone, nor can it be supposed that the presence of intense flames in a room can be a source of ozone sufficient to be a means of removing the impurities of the air by oxidation. The ozone and in some cases hydrogen peroxide are merely an effect of the high temperatures of the inner zones of a very hot flame. In some cases the ozone may escape being decomposed, as by blowing a strong current of air through a tube into the flame of an ordinary Bunsen burner. It is an interesting fact that ozone is produced by ultra-violet rays, and the hot flame of an atmospheric burner working under perfect conditions is rich in these rays. The ultra-violet rays are probably the source of ozone in nature, the rays themselves, of course, owing their origin to the sun.—Lancet.

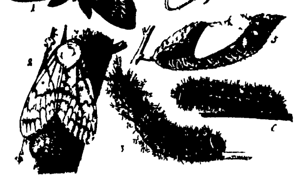


Fig. 6.—1. Male Sponge Spinner. 2. Female Sponge Spinner. 3. Larva of Sponge Spinner. 4. Male Golden Tail. 5. Female Golden Tail Laying Eggs. 6. Larva Golden Tail.

COMBUSTION AND EXPLOSION.—II.*

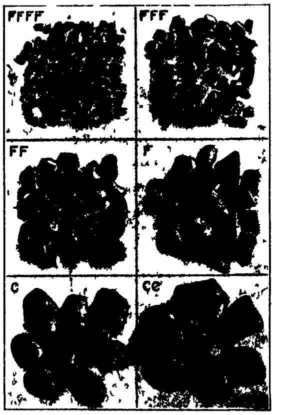
A PRIMER ON EXPLOSIVES FOR COAL MINERS.

BY C. E. MUNROE AND CLARENCE HALL.

Concluded from Supplement No. 1780, Page 106.

As may be inferred from what has already been said a large number of substances are known and used as explosives. The one longest known and used is gunpowder, which has certainly been used since early in the fourteenth century. This is made by intimately mixing 75 parts of India saltpeter (potassium nitrate) with 15 parts of charcoal and 10 parts of sulphur. Each of these ingredients is ground to a fine powder and then they are ground together while moistened with water in the proportions given until the mixing is complete. The material is pressed into cakes which are then broken up into grains, which are dried, glazed by rubbing, and sorted by the aid of sieves into the various sizes.

Formerly this India saltpeter powder was used both in guns and in blasting, and while to-day some of it is used in blasting, the larger part of what is used in this country under the name of black blasting powder is composed of 73 parts of Chile saltpeter (sodium nitrate or nitrate of soda), 16 parts of charcoal and 11 parts of sulphur. This black blasting powder is made in a manner similar to that described for gunpowder, but less time is spent in making the mixture and the charcoal is usually obtained from coarse-grained woods. The Chile saltpeter will supply more oxygen and supply it more easily than the India saltpeter, and therefore is a better and cheaper oxidizing agent, but the Chile saltpeter is not used in the manufacture of gunpowder because when it is exposed to moist air it takes up water by absorption from the air and becomes wet, and powders or other explosives in which this Chile saltpeter (nitrate of soda) is used likewise take up moisture when exposed to the air and become damp, so that it is difficult and sometimes impossible to set fire to them. As gunpowder for use in guns and firearms must often be kept for a great many years and yet always be in such condition that it can be fired at any moment with certainty, this property of absorbing moisture from the air makes the nitrate of soda unfit for use in gunpowder, but blasting powder is not expected to be stored for years, and in magazines at mines it is quite possible to store it for a while so as to protect it from exposure to damp air. Besides, by proper management it is possible to obtain this blasting powder fresh from the manufacturer and use it promptly while in that condition, hence advantage may be taken for economic use of the superior efficiency and cheapness of the nitrate of soda in the manufacture of blasting powders if we keep them dry.



GRAINS OF BLACK BLASTING POWDER

Black blasting powder comes into the market in the form of grains whose edges have been rounded off by rubbing together in a revolving barrel and which are usually coated on the surface or glazed, as it is termed, with graphite or black lead. The object in rounding and glazing the grains is to render them free running, and the glazing also serves to delay somewhat the taking up of moisture from the air by the grains.

The powder is divided into grades according to the size of grains as separated and collected by sieves of different sizes of openings. The sizes most usually offered for sale are called CC, C, F, FF, FFF and FFFF. Of these CC represents the largest grains, about one-half inch in diameter, and FFFF represents the smallest grains, about one-sixteenth inch in diameter. The relation between the letters designating the sizes of the powder and the sieves by which the different sizes are separated is shown in the following table:

Relation Between Sizes of Black Blasting Powder and Separating Sieves.

Size of Grains.	Diameter of Round Holes in Screens through Which Grains Pass.	Diameter of Round Holes in Screens on Which Grains Are Caught.
CC	1/2 inch	2 inch
C	2 inch	1 inch
F	1 inch	1 inch
FF	1 inch	1/8 inch
FFF	1/8 inch	1/16 inch
FFFF	1/16 inch	1/28 inch*

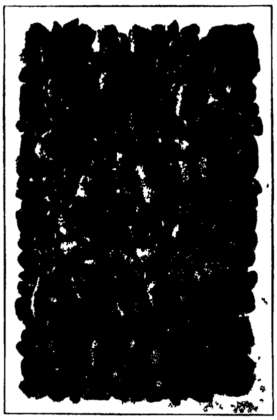
To get the best results in the use of this powder in blasting the grains should be of uniform size, so that the miner, having determined the best size of charge, may have no difficulty in repeating it. Unfortunately not enough care is taken in separating the grains into the different sizes, and powders have appeared in the market in which a considerable number of different sizes of grains were mixed together, so that the miner has obtained quite different results from his different shots in the same mine of coal with the same grade of powder. Moreover, when large and small grains of powder are mixed in a charge, the fine grains, which burn freely, may produce in burning enough pressure to throw the large grains out into the mine, where they can set the gas and dust afire. This makes such a mixture of grains a dangerous one in use.

It has already been said that many other substances besides India saltpeter (potassium nitrate) and Chile saltpeter (sodium nitrate) are known which contain oxygen in such quantity and in such manner that they may be used as the oxidizing agents in forming explosives. Among these is the substance known as potassium chlorate. More than one hundred years ago an eminent French chemist showed that when it was mixed with combustible substances a most powerful explosive was produced, but unfortunately this mixture was found to be so sensitive to friction, blow, and heat as to endanger the lives of those who sought to handle and use it. Many of the mixtures produced with potassium chlorate are so easy to prepare and explode with such violence that a great many persons have been tempted to make them, but until recently all those that have been devised have been rejected as unfit for use because they were liable to destroy those who attempted to make use of them. It is found, however, that when dry and finely ground potassium chlorate is mixed with a body like starch and with oil and other substances an explosive is produced that is fairly safe to handle. Mixtures of this nature have met with some use in Europe.

Attention has also been called to the fact that when purified dry cotton is immersed in nitric acid in the proper manner it is changed into an explosive substance through reaction with the nitric acid. When we withdraw the fibrous cotton from the nitric acid, wash it thoroughly to remove any acid that sticks to it, and then carefully dry it at a low temperature, the cotton appears unchanged to the eye even when examined most carefully. It has, however, become a little harsh to the touch. When rubbed it becomes electrified so that it sticks to the fingers, and when a flame is applied to it it flashes off with great rapidity. In practice a mixture of sulphuric acid is used with the nitric acid in nitrating the cotton. By varying the strength and the proportions of the nitric and sulphuric acids, their temperature when the cotton is dipped in them, and the length of time that the cotton is in them, we can get a number of different products varying in the rate at which they will burn and in the degree to which they are soluble in various solvents, but every such product results from the replacement of more or less of the element known as hydrogen which was present in the cotton by nitrogen and oxygen (indicated by the formula NO) which came from the nitric acid. Such a product obtained by the action of the nitric acid on the cotton will take fire and burn the more easily the greater the number of NO groups that have replaced hydrogen in the cotton. We may for convenience divide these various products into two classes. Those which contain the fewer of these NO groups are called pyroxylin or soluble nitrocellulose or collodion cotton, and those which contain the greater number of the NO groups are known as gun cotton.

In the manufacture of gun cotton the very strongest nitric and sulphuric acids are used. After the product has been washed so as to remove most of the acid sticking to it, it is pulped while wet into a fine powder in a machine such as is used in pulping paper stock, and when the gun cotton has been washed in this powdered condition so as to remove the last traces of acid it is molded into blocks or sticks and is used as an explosive in that form.

Nitroglycerin is prepared by slowly running glycerin into a mixture of the strongest nitric and sulphuric acids, the whole being stirred and kept cool during the process of mixing. The reaction which takes place between the glycerin and the nitric acid is similar to that which takes place with the cotton. As a result of the reaction NO groups from the nitric acid replace hydrogen in the glycerin, and the mild, sweet, harmless glycerin is thereby changed into the powerful and dangerous explosive nitroglycerin. Nitroglycerin is a rather dense, oil-like liquid. When pure it is colorless, but as it appears in the market it is usually pale yellow. It is somewhat poisonous, and one may be poisoned by it not only through the mouth but also by breathing its vapor or by allowing the liquid to touch the skin. A drop of it touching the tip of the finger will usually soon produce a violent headache. Fortunately most persons lose their sensitiveness to poisoning after repeated contact, so that they cease to have the headache, but it would still be dangerous for these persons to get any of the nitroglycerin into the mouth. Nitroglycerin may freeze after long exposure to a temperature of 52 deg. F. and it must be thawed before it can be properly used as an explosive.



MIXTURE OF DIFFERENT-SIZED GRAINS OF BLACK BLASTING POWDER

Being a liquid, nitroglycerin is especially dangerous for ordinary use because it may escape from the cans or other vessel in which it is carried or stored and run off to considerable distances so as to increase the chances of accidental explosion by a blow or friction or heat, and also because it may, when placed in a bore hole, leak out into crevices or seams in the coal, and when fired give most undesirable results. In fact, during the middle of the last century, when it was offered for use, so many accidents occurred that many countries by law forbade its use or manufacture. We can less ver prevent a liquid from flowing about by absorbing it in a porous body, like a sponge. This has been done with nitroglycerin and the product is called dynamite. Dynamite consists of nitroglycerin absorbed in a solid body called the "dope." There are many dynamites. One of the earliest known and used was made by absorbing the nitroglycerin in powdered rotten stone. As the rotten stone could neither burn nor explode it was called an inactive dope and there are several varieties of dynamites with inactive dopes. On the other hand nitroglycerin may be absorbed in gunpowder. As the gunpowder explodes as well as the nitroglycerin when the dynamite is fired the gunpowder is called an active dope. There are a large number of dynamites made with active dopes and with varying percentages of nitroglycerin. The standard straight dynamite used at the Pittsburg testing station may be taken as an example of a dynamite with an active dope. It consists of the following:

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* Abstracted from Bulletin 423, published by the United States Geological Survey.

* Square holes.

Composition of Standard Straight Dynamite

	Per cent
Nitroglycerin	40
Nitrate of sodium	44
Wood pulp	15
Calcium carbonate	1
	100

Since it is a liquid nitroglycerin like other liquids acts as a solvent and it has been found that under certain conditions it can dissolve soluble nitrocellulose and that the mixture thus formed will set to a jelly-like mass. In this way or sometimes by the use of other solvents also the substance known as explosive gelatin is formed a substance that in some respects is regarded as the most nearly ideal explosive. However it is too powerful for ordinary use in blasting and it is therefore diluted by mixing it with a dope such as the nitrate of soda and wood pulp used in straight dynamite. The mixture so formed is known as gelatin dynamite.

It has already been said that nitroglycerin when exposed to ordinary winter temperatures will freeze. Dynamite explosive gelatin and gelatin dynamite will also freeze because all of them contain nitroglycerin and like nitroglycerin all of these substances should be properly thawed before any attempt is made to use them.

Each of these substances is put upon the market in the form of sticks or cartridges which are made by wrapping up cylinders of the material in paper. The wrappers for dynamite and gelatin dynamite are paraffined to protect them from the action of water and the moisture in the air because they contain nitrate of soda and hence may absorb moisture and become spoiled and develop new sources of danger in handling and use. These sticks usually vary in size from seven-eighths inch to $2\frac{1}{2}$ inches in diameter and they are usually 8 inches long. They are usually packed in cases containing 50 pounds each. The mark "This side up" or a design on the top of the case shows the position in which the cartridges are packed. The cases should always be placed so that the cartridges lie on their sides and they do lie so when the cases are stored with their top sides up.

For use in coal mines it is suggested that the explosive be packed in cases or cartons containing the weight which the law of the district permits being taken into the mine.

Besides cotton and glycerin there are a large number of substances such as sugar and starch that are chemically related to cotton and glycerin and through the action of nitric acid particularly in the presence of sulphuric acid give rise to explosive substances. Many of these have been produced but so-called nitro-starch is the only one that seems to have any commercial importance. During the last ten years this has attracted some attention and it has been offered for use both in this country and in Europe. It is a finely powdered substance like starch itself but it does not need as starch does to be suspended in the air in order to explode on ignition because even when in a pile it will burn with great rapidity if set afire and through the action of a detonator it explodes with great violence. It is not yet used by itself but is used as a component in various explosive mixtures particularly dynamites.

Attention has been called to the use of potassium nitrate and sodium nitrate in the manufacture of explosives. In recent years another nitrate formed by the union of ammonia with nitric acid and known as ammonium nitrate has come to be somewhat largely used. It has been used in this country for more than a quarter of a century in the manufacture of some dynamites taking the place of sodium nitrate and having the advantage over it that on explosion it goes completely into gases but it has come to be used in Europe in the manufacture of special explosives for use in coal mines for the reason that on explosion it forms a large amount of water and this lowers the temperature of all the products of the explosion. In the making of several of these ammonium nitrate powders various substances obtained from coal tar which generally have been acted upon by nitric acid are mixed with the ammonium nitrate.

The substances derived from the coal tar after having been acted upon by the nitric acid are known as nitro-substitution compounds. One of the substances obtained from coal tar which is perhaps best and longest known is carbolic acid and when this reacts with strong nitric acid it gives us the nitro-substitution compound known as picric acid. Other substances obtained from coal tar that are pretty well known are benzene toluene and naphthalene. When these are acted upon by nitric acid we obtain from them the nitro-substitution compounds known as nitrobenzene nitrotoluene, and nitronaphthalene. These are but a few of the many substances that may be obtained from coal tar and furnish through the action of nitric acid upon them nitro-substitution compounds. All the nitro-substitution compounds will form explosives when mixed with oxidizing agents such as ammonium nitrate or other nitrates or chlorates and many explosives have been made from such mixtures. Moreover, these nitro-substitution compounds have been used as components of dynamites particularly because they lower the freezing point of the nitroglycerin in the dynamites.

The nitro-substitution compounds are so called because the NO groups in them obtained from the nitric acid are directly connected to the carbon atoms in the original material replacing hydrogen atoms, whereas in gun cotton nitroglycerin and bodies of that sort the NO groups are linked to the carbon atoms of the original substance by means of atoms of oxygen. The nitro-substitution compounds are usually yellowish to red crystalline solids but as most of these solids are easily melted they are often sent out in compact masses. A few of them are liquids at ordinary temperatures and they have a marked aromatic odor. Some of these substances are poisonous. Great care should be taken in handling all of them and one should especially avoid breathing their vapors.

As has been stated above the most common fulminates are produced by dissolving a metal such as mercury in a strong nitric acid and pouring the solution into common alcohol. When the proportions used are correct and the operation is carried out in a proper manner after an apparently violent reaction there will be produced a mass of fine gray crystals that look quite alike and this is known as fulminate of mercury or mercury fulminate. The crystalline powder thus produced is washed with water to free it from acids and because of its extreme sensitiveness it is kept soaked with water until desired for use. It is principally used in loading blasting caps or detonators and for this purpose the water may be removed from it by alcohol and it may be loaded into the copper capsules while wet with alcohol but it should be always borne in mind that this mercury fulminate even when thoroughly soaked with or sunk under water or alcohol will explode with tremendous violence if only a small amount of the dry fulminate be exploded while touching it or very near it. Hence extreme precautions should always be taken with mercury fulminate whether the substance be wet or dry.

The manufacture of explosives is by no means simple. Unless all the materials are of the proper kind and in the proper condition and they are used in the proper order in the proper manner with the proper tools and vessels and with all the proper precautions at each stage of the operation the manufacture is a very dangerous thing to undertake and it is very foolish for anyone to undertake it by himself.

NEW USES OF PAPER

People in general have no idea of the vast number of substances which paper has the power of absorbing or of the importance which this unique capacity for absorption possesses for the paper-making and other industries. The fact that unsized paper readily absorbs liquids is familiar to everyone through his experience with blotting paper but that the absorbing power of paper is almost unlimited and is not confined to liquids but includes solids and gases is a fact little known and little utilized. Yet there is scarcely one manufacturing industry which could not derive some advantage from the employment of paper to which the most diverse and opposite properties can be given with the aid of this remarkable power of absorption.

For example paper could be used with advantage in place of celluloid in many cases. Celluloid is highly valued for its many-sidedness. It is transparent and flexible in the form of photograph films and opaque hard and rigid in the form of imitation ivory. It can be pressed cut turned and worked in many other ways. All of these things can be done with paper which can also unlike celluloid be made incombustible. For years an incombustible substitute for celluloid has been sought by hundreds of chemists. The only uninflammable substitute yet discovered is the substance called cellit which is too expensive for practical use. Inflammable moving picture films are especially dangerous and have caused many fires owing to the concentration of a powerful beam of light and heat upon the film. Hence various safety appliances have been introduced but it has not occurred to anyone to substitute transparent fireproof paper for the very inflammable celluloid. Yet a German patent was issued years ago for a process of making transparent paper lantern slides which could be easily adapted to the manufacture of moving picture films and would greatly lessen the danger of fire as even paper which has not been fireproofed is far less inflammable than celluloid. Transparent paper however can be made absolutely fireproof, without impairing its transparency by coating it with a thin film of waterglass.

The great value of the capacity of paper to absorb solids may be illustrated by another example. The most essential ingredient of the majority of filters consists of finely divided charcoal which retains the solid particles suspended in the liquid which is to be filtered. In many cases it is very difficult to obtain pulverized charcoal of the requisite fineness and other qualities. E. Piccinini of Pisa has met this difficulty by impregnating paper with charcoal powder. Paper treated in this way is very different from ordinary filter paper. It possesses the properties characteristic of charcoal filters and it is also available for the filtration of liquids which attack common filter paper. Moreover its high carbon content makes it a good conductor of electricity and this property can be utilized in the construction of electrical apparatus.

In the electrotechnical field the contradictory properties which may be conferred upon paper by means of its power of absorption are strikingly illustrated, for while paper is made a good electrical conductor by impregnating it with carbon its conductivity can be entirely destroyed by saturating it with some other substances. Hackethal has constructed paper insulation for electric wires which is permanently weather-proof and very little affected by acids. The wire is wrapped in a special manner with paper impregnated with suitable substances.

The absorbing power of paper is beginning to be utilized in the protection of various objects from water and fire. Paper can be made waterproof by saturating it with oil or with resins and tar. Tarred paper is now used to some extent, for the purpose of making boats watertight. In this way the necessity of tarring the entire boat is avoided and a better result is obtained. In tarring boats with a brush it is difficult to avoid the formation of bubbles and when these bubbles break the wood is laid bare so that the effect of the tarring is doubtful. In a process of fire-proofing which has recently been introduced in America, the objects are first covered with paper, fastened by means of a suitable adhesive to a thickness of 1/10 inch or more. A paste consisting of wood pulp and silica mixed with hemp or other fibrous material is applied to the paper covering and after drying the surface is painted with a pigment mixed with a solution of waterglass. According to report the coating formed in this manner does not peel off even at a bright red heat—a property which is due largely to the impregnation of the paper with various substances before it is applied to the object. It is interesting to note that this latest application of the absorbent power of paper is very old in principle. The first volume of the Chemische Annalen published in 1788 contains a description of a variety of paper called "stone paper" which was prepared by Faxe for fireproofing the interior of buildings and ships.

A systematic and thorough investigation of the capacity of paper to absorb substances of various kinds and a study of the properties of the products thus obtained would doubtless be followed by many other applications of impregnated paper.—Umschau.

* * *

Even those who are aware of the immense value of pure research forget the fact that the aptitude for scientific investigation is as rare as the gift of poetry to which in many respects it is allied for both are creative gifts rare and precious. They forget that it is impossible to ascertain without trial whether a man possess it or not and that this trial can only be made when he has passed his student days and looks to support himself by his own exertions. To provide for this support money is needed, and studentships must be established in considerable numbers from the holders of which those who show that they possess the gift of research can be selected and promoted to higher posts in which their gift can find full opportunity, but we want more than this—we want compensation for those whom we have encouraged to make the trial and who have failed to show that they possess the gift and an outlet by which they can emerge and find work in practical life.

THE ORIGIN OF STELLAR SYSTEMS.

PROF. SEE'S RESEARCHES.

Soon the second volume of Prof. T. J. J. See's "Researches on the Evolution of the Stellar Systems" will appear. The work deals with a subject which has engaged the uninterrupted attention of the author for a quarter of a century; but it is chiefly within the past two years that he has succeeded in making the remarkable discoveries recently made public through the columns of the Astronomische Nachrichten. These have given a new aspect to the whole science of cosmogony, and have consisted in the development of the Capture theory, which has awakened profound interest throughout the scientific world.

Heretofore the problems of cosmogony have been considered well-nigh hopeless if not entirely insoluble. It is barely three years since the late Prof. Newcomb, one of the greatest astronomers of modern times, declared (in Popular Astronomy for November, 1906, p 572) that he "still retained a little incredulity as to our power, in the present state of science, to reach even a high degree of probability in Cosmogony" In view of the false premises underlying all the reasoning since the time of Laplace, and the resulting failure of many eminent investigators who attempted to solve the problem, such incredulity is not remarkable.

Prof See seeks to prove that the solar system was formed from a spiral nebula internally devoid of hydrostatic pressure, and therefore the planets have not been detached from the sun by rotation, as held by Laplace, but have been captured and added on from the outer parts of the nebula, and are therefore in no sense of the word children of the sun, as has been generally held for more than a century The satellites likewise have been captured by their several planets, and not one of them detached by rotation from the central bodies which now govern their motions. Accordingly they are not, as we have so long been taught, children of the planets and grandchildren of the sun, but were originally independent planets moving in regular elliptical orbits about the central mass of our system, and were subsequently captured by the several planets about which they now revolve as satellites

Our moon, likewise, was originally a planet which neared the earth and was finally captured and made a satellite. It was no part of the terrestrial globe detached by rapid rotation, as has been generally believed since the time of Anaxagoras, B C 500-428, and more recently taught by Laplace, Lord Kelvin, Sir George Darwin, Poincaré, Pickering, and other eminent writers.

The planetoids are the surviving remnants of millions of small planets with which our solar nebula was originally filled. At one time they extended over the whole planetary system, but most of them have at length been swallowed up by colliding with the larger bodies, and those which survive have been thrown mainly within the orbit of Jupiter.

The rotations of the planets on their axes have been produced by the capture and absorption of these small bodies, which may be called either asteroids or satellites.

As the satellites have all been captured, but were once independent planets, it will not seem strange that a few of them have retrograde motions; the capture theory explains this in a simple and easy manner, and it is in accord with the latest researches on the celebrated problem of three bodies, the treatment of which has been much improved by Jacobi, Hill, Poincaré, Darwin, and other mathematicians.

As the planetary rotations are due to the capture and absorption of satellites, theory shows that the larger planets, as Jupiter and Saturn, ought to rotate most rapidly. This is in accordance with observation, and the nature of the cause at work shows that the earth never could have rotated much if any more rapidly than at present.

The theories long current in geology and astronomy that the earth once rotated in two or three hours, so rapidly that it threw off a layer of peripheral matter now collected into the moon, are held to be quite devoid of foundation. The effect of this advance will be to show that the globe never was highly oblate, and to correct the theories of geology

The cause of the secular acceleration of the moon's mean motion has been one of the leading problems of astronomy for over two centuries In spite of all the researches of the greatest mathematicians, there remains an outstanding inequality which cannot be accounted for by gravitational or other definite theory This anomaly is now explained by the fact that the moon is a captured planet, and therefore slowly nearing the earth, owing to the action of a resisting medium, in the nature of cosmical dust pervading the regions where the planets move. The moon was once an independent planet, and when revolving in the region of the asteroids, suffered numerous collisions with satellites; this is the cause of the immense, round, sunken craters which have puzzled astronomers since the time of Galileo The traditional theory that they are volcanic is quite devoid of foundation, and now definitely and finally disproved

The roundness of the orbits of the planets and satellites has been remarked from the earliest ages of science, and this phenomenon, which led Plato, Aristotle, and other Greek sages to declare that the heavenly motions are perfect because they are circular, is now shown to be due to the secular action of a resisting medium which has reduced the size of the planetary orbits and well nigh obliterated their eccentricities, and not at all to these bodies having been detached by rotation and set revolving in orbits which were originally nearly circular, as incorrectly held by Laplace

Around each planet there circulates a vortex of cosmical dust, of which the satellites alone are large enough and bright enough to be visible in our telescopes The descent of this material against the surfaces of the sun and planets gives rise to the observed but heretofore perplexing accelerations of the equatorial regions of these globes The descent of matter upon the sun increases its mass and gives rise to a small secular acceleration of the earth, which, as Mr Cowell has shown, is also indicated by the observations of the eclipses during the past 3,000 years

Just as the earth never rotated very rapidly, and has not been appreciably retarded by the effects of tidal friction, so also Venus likewise has escaped a corresponding retardation of axial rotation, and still rotates in 23 hours 21 minutes, as has been held by observers since the days of Cassini, 1667 Accordingly it follows that the conditions of this planet are more like those of the earth than any other body of our system Mars rotates 41 minutes slower than the earth, while Venus rotates 35 minutes faster; and as the former planet is about as much outside of the earth's orbit as the latter is inside, there is seen to be a profound physical cause which has operated to establish the period of 23 hours 21 minutes first inferred from observations taken over two centuries ago. The planet Venus, therefore, is habitable and probably inhabited by some kind of intelligent beings.

The solar system extends much beyond Neptune, and several of the unseen planets revolving near the outskirts of the system may yet be discovered by observation. Neptune's orbit is too round for it to be the last of the planets, because this roundness indicates that the nebulous medium was quite dense at that distance, and consequently that the limits of the system are much farther out

It has long been known that the periodic comets are captured bodies which have suffered transformation of their orbits under the action of the planets. The theory is now extended to the planetoids and satellites, and these two classes of bodies are shown to be closely related The survival of satellites near the principal planets shows that our system was once filled with these small masses Such moons naturally develop in the condensation of a nebula, and all nebulæ include multitudes of solid globes in addition to the gaseous matter shown by the spectroscope

The collisions of satellites with the larger globes, as shown by the battered surface of our moon, give rise to part of the light of the nebulæ, and no doubt also to some of the cosmical dust with which they are filled

The whirling of the spiral nebulæ is due to the unsymmetrical meeting of two streams of nebulosity, which thus coil up, and settle down under the effects of mutual gravitation; or to the mere gravitational settling of a nebula of unsymmetrical figure The inevitable result is a whirling cosmical vortex, and eventually a star surrounded by a cosmical system is formed

Nearly all single stars have planetary systems revolving about them, and in the immensity of the starry heavens an infinite number of the planets are habitable, and no doubt actually inhabited Life is almost as general a phenomenon in the universe as matter itself, though our dominant materialistic philosophy is loth to admit it

We can see only visual and spectroscopic binary stars in the sidereal universe, owing to the immense distances which render the smaller bodies wholly invisible in our telescopes, but we know, from the example of the solar system and from the causes which have operated in its formation, that planets and satellites exist everywhere about the fixed stars

In star clusters the motion is shown to be of a spiral character, as in the nebulæ, where we can trace the streams of movement by the nebulosity, and the same theory is applied to the Milky Way It is shown by calculation based on the best modern data, that the extent of the sidereal universe actually exceeds the vast dimensions found by Sir William Herschel, and of late years held to be extreme

The modification of the original obliquities of the planets is held to depend on the capture and absorption of satellites. It is shown that in this way the obliquity of Jupiter was practically obliterated. If Saturn's mass were to be augmented till it became equal to that of Jupiter, his obliquity likewise would disappear The work of Stratton, implying planetary inversion, is shown to be inapplicable to the solar system, because based on a false premise

The obliquity of Mars is greater and that of Venus probably smaller than that of our terrestrial globe This is another reason for holding that the planet Venus is habitable, if not actually inhabited All the principal phenomena of our system are thus harmonized and explained, and the laws are found to be general for the entire sidereal universe

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MIGRATING STARS.

Most readers, of course, know that the constellations of the heavens are only convenient groupings of the stars arranged in ignorance and that the shining suns which appear in them may be void of connection one with the other Modern astronomy, as Prof. H. H. Turner points out in an article in the Fortnightly, has discovered strange affinities in the movements of stars far removed from one another in the sky. The great seven of the Plow, for example, are not all related. The middle five are speeding in company away from the earth; the two pointers at the end of the Plow are coming toward us. But these two are not alone in the heavens. They belong to the same company as Sirius, to which company belong also six other stars—the brightest star in the Northern Crown, one in the Lion, one in Eridanus, one in Auriga. These have been discovered by Dr. Ejnar Hertzsprung, of Göttingen. They are scattered widely over the sky, and there may be others still undetected. They move in parallel courses through the universe like a flock of migrating birds, and some of this brilliant squadron have passed us by and some have not yet caught us up. It is possible that our sun is one of a cluster of stars moving like this The variable star Algol may be moving with us; and so may be Beta in the constellation of Perseus and one star of the Eagle and two of the Swan may be going our way. "Migrating stars," the Savilian professor calls these suns whose movements are now under analysis, and their peregrinations are more mysterious than those of any birds Can it be, he asks, that they have some common association of birth—perhaps some vast nebula collected into stars, billions of years ago, as a cloud condenses into drops, and yet retained in them its vast extension and its primeval velocity?

Prof, Turner has something to say about the "personal equation." If any two people observe a phenomenon—the passage of a star, for example—they will not accredit it with precisely the same period of duration One observer will be a little slower, one a little quicker than the other; and both will differ from the average It will usually be found that one is always slower and one always quicker; and the difference of each from the average is a recognized and estimated quantity, which is called the observer's "personal equation." But according to Prof. Turner, the simple notion of a constant peculiarity for each observer has been much elaborated The personal equation changes if a new instrument be used, or if a fainter star be observed without change of instrument, or as the observer grows older, or as his health varies On one occasion Prof Turner was associated with an eminent French astronomer in determining the longitude of Paris, and at dinner with his colleague before beginning the night's observations, ordered a bottle of white wine as a change from the red, which had been customary His action was not approved. "Ca changera l'équation personelle" was the grave comment The conception of an observer has, in fact, steadily increased in complexity, until he is now regarded as liable to be deranged by almost every wind that blows; only by multiplying observers can accurate results be obtained as wisdom comes from a multitude of counselors Another anecdote is added—that of Prof Ross's card catalogue of variations in the observations of the stars, which was so precious that in course of compilation it was always kept by the observatory window at Albany, so as to be thrown out—the first thing to be saved—in case of fire.

THE SEVEN WONDERS OF THE WORLD.

BY F. M. FELDHAUS.

The number seven has always played a prominent part in human life. Hence it is not surprising that seven, and only seven monumental structures were included in the ancient Greek catalogue of the wonders of the world. The catalogue has been handed down to us by tradition, but the works themselves, with the exception of the Pyramids of Egypt, have either vanished from the face of the earth or exist only as ruins.

By courtesy of the Sphere. From a painting by Kupka.

THE LION-ADORNED STEPS LEADING TO THE TOMB OF MAUSOLUS.

The tomb was partly constructed by Artemesia, the wife of Mausolus, in the fourth century B. C.

THE SEVEN WONDERS OF THE WORLD.

The fame of the Seven Wonders of the World appears to have rested upon their hugeness (real or alleged) and the oddity of their forms and construction. A finer taste, less easily dazzled by externals, would have selected for admiration objects very different from the Egyptian Pyramids, the Hanging Gardens of Semiramis, the temple of Diana at Ephesus, the statue of Jupiter at Olympia, the Colossus of Rhodes, the Pharos at Alexandria and the Mausoleum at Halicarnassus. With the exception of the Pyramids, the most ancient of all, these structures were products of decadent civilizations, and the description of them conjointly as the Seven Wonders of the World was also made in an age when taste and genius were on the decline. The earliest known attempt to picture them was made in the seventeenth century, after scientists, travelers, and artists of the Renaissance had furnished material for plausible reconstruction. The remarkably versatile Jesuit missionary Athanasius Kircher was born near Fulda in 1601. He traveled far and wide and wrote a goodly number of great folio volumes, illustrated with excellent copper plate engravings. He was especially fond of describing and depicting the wonderful and mysterious. Among the subjects of his books are the Seven Wonders, Noah's ark, obelisk, the interior of the earth, light, and magnetism. His opinions, imposed on his contemporaries by his great personal authority, have been accepted without question until very recently.

The Seven Wonders have enriched modern languages with a number of words—mausoleum, colossal, pyramidal—and the expression Herostratic fame, derived from Herostratus, "the aspiring youth who fired the Ephesian dome."

The Pyramids were built more than four thousand years ago, as monumental tombs of Egyptian kings. Most of them, including the largest, stand in lower Egypt near the west bank of the Nile, where the ruins of sixty-seven similar structures have been found buried under a pall of sand. The largest is the Pyramid of Cheops or Chufu. It was originally 233 meters (764 feet) square at the base and 146.5 meters (480 feet) high, but the length of each side is now reduced to 227.5 meters (746 feet) and the height to 135.2 meters (443½ feet).

Piazzi Smyth, late astronomer royal for Scotland, and a publisher named Taylor discovered a number of wonderful things in the dimensions of the Pyramid of Cheops, for example, that the height bears the same ratio to the periphery of the base that the radius of a circle bears to its circumference (the ratio 3.14159, denoted by the symbol π). Hence these ingenious investigators inferred that the Egyptians of 4,000 years ago knew the value of π to the fifth decimal place. They found the length of the side of the base equal to one ten-millionth part of the radius of the earth, the height equal to one thousand-millionth part of the distance of the earth from the sun, and obtained a unit of length by dividing the length of the base by the number of days in a year. These discoveries were taken to indicate that the Egyptians know, long before the time of Pythagoras, that the earth is spherical, and knew its radius and its distance from the sun with greater accuracy than Copernicus or Kepler did!

It is certain, however, that the inclined passage which leads to the interior of the pyramid would, if extended outward, meet the sky very near the point which marked the position of the Pole star 4,000 years ago. Hence the lines of the plan were directed by the stars.

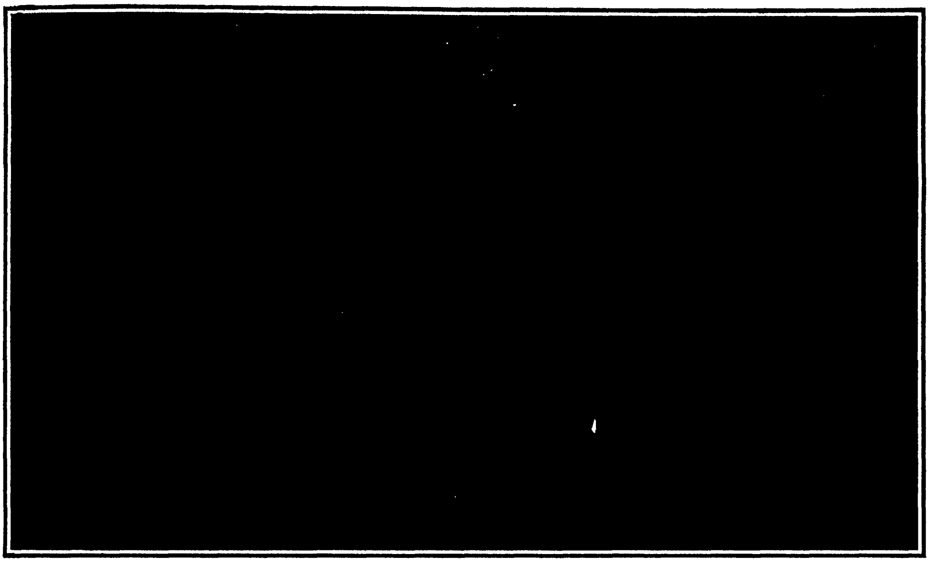
The British investigators also discovered in the Great Pyramid the correct value of the density of the earth and found that its mass was equal to that of the earth divided by 10^{1}. Hence they concluded that it was designed to serve, not as a tomb, but as an eternal record and monument of scientific discoveries and standards of measurement. But as the oldest known mathematical treatise, the Rhind papyrus, written about 1500 B. C., contains only the merest rudiments of arithmetic, it is not likely that the Egyptians were familiar with advanced mathematics a thousand years earlier.

The Hanging Gardens of Babylon, which were supposed to have been constructed by the more or less fabulous queen Semiramis, owe their celebrity to the fantastic descriptions given by Roman and Greek writers. Recent excavations have shown the gross exaggeration and fictitious embellishments of these accounts. The mighty Babylon of the classic authors has shrunk to one-fiftieth of its traditional area as a result of thorough study of the cuneiform inscriptions. The immensely high and thick walls, with their hundred gates, appear to have been largely works of the imagination.

Yet it is not surprising that Greek merchants and other travelers, visiting the ancient metropolis on the Euphrates in the fifth and sixth centuries before our era, were amazed by the size and wealth of the city and the magnificence of its palaces and other buildings, nor is it surprising that they embellished the stories which they carried home. Recent explorers claim to have found the Hanging Gardens of Semiramis in the ruins of the third palace of Nebuchadnezzar, who reigned from 605 to 561 B. C. This palace or garden stood on a broad platform supported by foundation walls 100 feet in height, the ruins of which lie buried in the hill called Babil just within the north wall of the city. An inscription of Nebuchadnezzar informs us that the third palace was erected "where the brick wall meets the north wind." Rassam claims to have found remains of wells or shafts, through which water was raised to the terrace. The bricks of this royal palace are now being used in building a dam across the Euphrates.

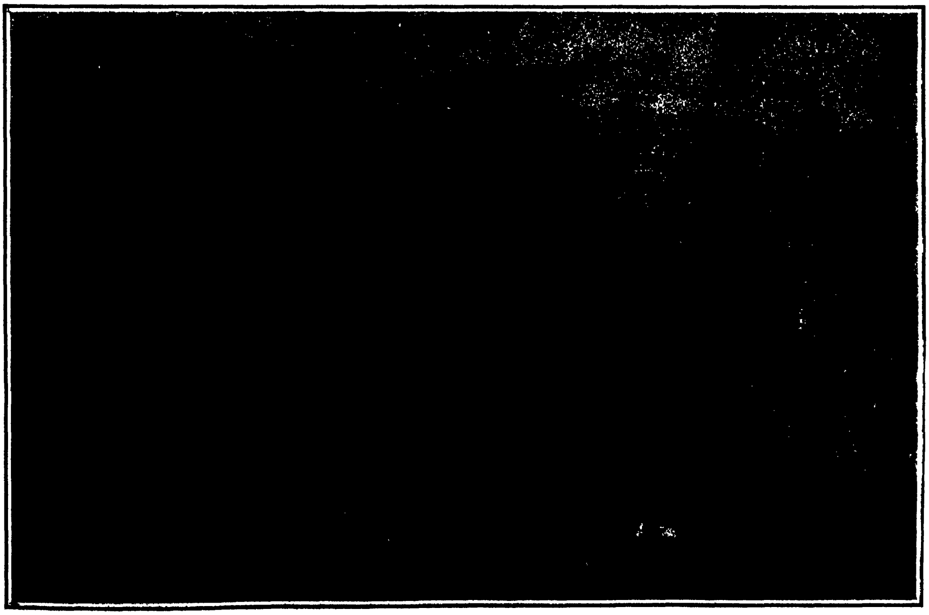
Interesting in this connection are the words of Frontinus, who superintended the construction of the great aqueducts of Rome, 1,700 years ago: "Can one compare with these wonderful aqueducts, which supply so many needs of humanity, the useless pyramids and other famous structures?"

On the night when Alexander the Great was born, in the year 356 B. C., a youth named Herostratus set fire to the Temple of Artemis, or Diana, at Ephesus, with the avowed object of making his name immortal. He was put to death and it was decreed that his name should be omitted from the records But his name was rescued from oblivion and so his longing for posthumous fame has been gratified The temple, the erection of which had occupied 120 years and cost a fabulous sum of money, was rebuilt after the conflagration by the united efforts of all the princes of Asia Minor on so magnificent a scale that it continued to be reckoned among the Seven Wonders It was four times as large as the Parthenon at Athens, glittered with gold and gems, and contained 127 columns, adorned with reliefs, in honor of the 127 princes who had impoverished themselves—or their subjects—in its construction The fame of Diana of the Ephesians is attested by the New Testament The restored temple was de-



"OSIRIS, KING OF THE NORTH AND SOUTH, MEN-KAU-RA, LIVING FOR EVER THOU SHALT NEVER MORE HAVE ENEMIES, O KING OF THE NORTH AND SOUTH, MEN-KAU RA, LIVING FOR EVER"—INSCRIPTION ON THE COFFIN OF PHARAOH BURIED IN PYRAMID

The Pyramids imposed on the classic imagination as much as they do on the modern mind They owe their endurance to extreme simplicity of form In the foreground of this picture the priests are burning offerings at the shrine constructed between the gigantic paws of the Sphinx The remains of the paws have silted up and have largely disappeared from view



By courtesy of the Sphere

From painting by Kupka

BABYLONIAN CAVALCADE PASSING OVER TEMPORARY BRIDGE IN FRONT OF THE FAMOUS HANGING GARDENS OF BABYLON.

The hanging gardens did not really hang but were raised above one another in terraces as shown in this picture.

THE SEVEN WONDERS OF THE WORLD.

stroyed by Constantine and even its ruins have entirely vanished

To the Greeks the ideal image of their principal deity Zeus the Latin Jupiter was the colossal statue at Olympia the site of their most celebrated national athletic contests The statue was the work of the famous sculptor Phidias the friend of Pericles The seated figure was 40 feet high and was supported by a pedestal 12 feet broad The nude upper part was of ivory the draperies of gold the right hand grasped the globe of the earth the left the scepter adorned with the eagle Figures of Victory and dancing Hours and Graces surrounded the throne which was adorned with numerous figures in relief According to Strabo this great statue was housed in a temple so ill proportioned to it that Jove could not have stood up without knocking his head against the roof

The Colossus of Rhodes was a bronze statue of Apollo the god of the sun about 110 feet high which according to tradition straddled the entrance of the harbor of Rhodes It was completed, after twelve years labor in the year 285 B C Fifty years later it was destroyed with a large part of the city, by an earthquake and its reconstruction was prohibited by an oracle When the Arabs conquered the island of Rhodes in the seventh century the Mohammedan commander sold the remains of the colossus to a Jew from Edessa and 900 camels were laden with its fragments

The most renowned of the few lighthouses of antiquity was one erected according to tradition in 283 B C on the little island of Pharos in the harbor of Alexandria Its height is given as about 560 feet, its cost as 800 talents equivalent to $90 000 The Pharos was standing at the beginning of the fourteenth century It has since been destroyed but the time and manner of its destruction are unknown

The list of the Seven Wonders which begin with the Pyramids ends with another royal tomb the Mausoleum at Halicarnassus This monument was erected about 350 B. C., by Mausolus, king of Caria in Asi Minor, in honor of his deceased consort Artemisia was 164 feet high, and nearly 500 feet in circumferenc at the base Its broad and lofty dome was supporte by many columns and surrounded by a colonnade Th building was overthrown by an earthquake in the thi teenth century and its ruins furnished the Knights St John with material for the construction of a castl

All of the Seven Wonders were situated on th shores of the eastern part of the Mediterranean the Greek writers had been better acquainted wit the north of Europe or the south of Asia they woul probably have made a different selection Near Sali bury in England for example, stand the cyclopean r mains of the very ancient temple of the sun, whic are known as Stonehenge, and near Delhi in Indi stands a huge consecrated column of *iron* the castin of which would tax the resources of the best of moder foundries —Translated for the SCIENTIFIC AMERICA SUPPLEMENT from Gartenlaube

THE WRIGHT INJUNCTION.—I

EXTRACTS FROM THE COURT'S OPINION AND THE BRIEFS.

JUDGE HAZEL of the Circuit Court of the United States in Buffalo granted on January 3d a preliminary injunction to the Wright company restraining the Herring-Curtiss company and Glenn H Curtiss from manufacturing selling or using for exhibition purposes the Curtiss aeroplane

Following is the opinion rendered reprinted from Aeronautics almost *in toto* Starting out with a statement of why a gasless flying machine flies the Judge then cites paragraph 7 of the Wright patent saying

The claims relied upon are the seventh fourteenth and fifteenth It is sufficient to here set forth the seventh claim which in broad terms includes both the monoplane and biplane types of apparatus

7 In a flying machine the combination with an aeroplane and means for simultaneously moving the lateral portions thereof into different angular relations to the normal plane of the body of the aeroplane and to each other so as to present to the atmosphere different angles of incidence of a vertical rudder and means whereby said rudder is caused to present to the wind that side thereof nearest the side of the aeroplane having the smaller angle of incidence and offering the least resistance to the atmosphere substantially as described

The essential elements of such claim are an aeroplane or supporting surface the lateral portions of which are capable of adjustment to attain different angles of incidence and a vertical rudder in the rear of the machine Claims 14 and 15 included as elements a horizontal rudder which is positioned forward of the machine and means for raising and lowering it so as to present its upper or under side to the pressure of the wind

Judge Hazel goes on to explain that the surfaces of the Wright machine are connected together by upright stanchions extending lengthwise on the extreme front and rear portions thereof and are fastened on top and bottom of the planes by universal joints so as to permit the planes or surfaces to yield to pressure and incline upward and downward at their lateral edges or marginal extremities when the cord or rope fastened to the cradle is manipulated by the aviator The lateral yielding warping or distorting of the aeroplane is the essential feature by which the equilibrium is secured Its importance cannot be overestimated as it is shown that long before the Wright invention a method was sought by which equilibrium in mechanical flying could be secured and maintained Not only the conception of the idea of securing and maintaining equilibrium in the air but the appliances—the dynamic cause to achieve the result—originated in the minds of the patentees and took shape and form in the evidently simple method of slightly turning up and down the lateral ends or margins of the planes thus securing different angles of incidence The insurmountable obstacle with which prior inventors in this art struggled for years was the precipitate unbalancing or upsetting of the apparatus and such prior flying machines were therefore incapable of flights with any appreciable degree of success The affidavits indicate that the patentees did not use the means or identities of prior flying machines but solved the problem of maintaining equilibrium or lateral and front and rear balance by the introduction of new and practical elements and became pioneers in the field of flying machines of the so-called heavier-than-air type True some of the elements of the claims were old and also shown in the prior gliding machines but such machines without the combination which included a method of maintaining equilibrium or lateral balance were utter failures Hence the prior patents and publications apparently do not anticipate the Wright patent and the claims in controversy are entitled to a broad and liberal construction

The Wright patent is unadjudicated but such fact will not deprive the claimant of its right to enjoin infringement save where the prior art shows sufficient ground to doubt the validity of the patent '

It is argued by the Judge in the present case public acquiescence is claimed it appearing that Wright machines have made notably successful flights in France Germany and the United States He recites the first flight to which the attention of the public was attracted that at Kitty Hawk in December 1903 and points to the heralding by the newspapers of the country of the marvelous success attained that human flight had at last been first made possible by the Wrights He calls attention to public recognition of their success by organizations and by the presentation of medals citing two cases where such testimonials have been entitled to weight in support of the presumption of validity and practical utility That both Curtiss and Herring obtained detailed information prior to the construction of the Curtiss machine as to experiments made by the Wrights on the pressure of wind on curved and flat planes and mode of maintaining equilibrium in flights the former through correspondence between the Wrights and Lieutenant Selfridge and the latter from personal observation and investigation by Herring at the Kitty Hawk camp is set forth by the Judge

He mentions Herring's affidavit in which Herring asserts that he considered the Wright invention was 'limited to the lateral warping of the planes and not that it covered broadly the feature of lateral balancing '

This brings the Judge to the question of whether the Curtiss machine infringes the Wright He says

Defendants claim generally that the difference in construction of their apparatus causes the equilibrium or lateral balance to be maintained and its aerial movement secured upon an entirely different principle from that of complainant, that defendants aeroplanes are curved firmly attached to the stanchions and hence are incapable of twisting or turning in any direction, that the supplementary planes or so-called rudders are secured to the forward stanchion at the extreme lateral ends of the planes and are adjusted midway between the upper and lower planes with their margins extending beyond the edges that in moving the supplementary planes equal and uniform angles of incidence are presented as distinguished from fluctuating angles of incidence Such claimed functional effects however are strongly contradicted by the expert witness for complainant Upon this contention it is sufficient to say that the affidavits for the complainant so clearly define the principle of operation of the flying machine in question that I am reasonably satisfied that there is a variableness of the angle of incidence in the machine of defendants which is produced when a supplementary plane on one side is tilted or raised and the other simultaneously tipped or lowered I am also satisfied that the rear rudder is turned by the operator to the side having the least angle of incidence and that such turning is done at the time the supplementary planes are raised or depressed to prevent tilting or upsetting the machine On the papers presented I incline to the view, as already indicated that the claims of the patent in suit should be broadly construed, and when given such construction the elements of the Wright machine are found in defendants' machine performing the same functional result There are dissimilarities in the defendant structure—changes of form and strengthening of part —which may be improvements but such dissimilar ties seem to me to have no bearing upon the mean adopted to preserve the equilibrium which means ar the equivalent of the claims in suit and attain a identical result

'Defendants further contend that the curved o arched surfaces of the Wright aeroplanes in commercial use are departures from the patent which describes substantially flat surfaces' and that such construction would be wholly impracticable Th drawing Fig 3 however, attached to the specificatio shows a curved line inward of the aeroplane wit straight lateral edges, and considering such drawin with the terminology of the specification the sligh arching of the surface is not thought a material departure, at any rate, the patent in issue does not belong to the class of patents which requires narrowin to the details of construction

The Mattullath patent application is thrown out o consideration as an unsuccessful experiment '

The date when machines alleged to be infringements of the Wright first made their appearance i now put on record The Judge states

'Indeed, no one interfered with the rights of th patentees by constructing machines similar to their until July 1908, when Curtiss exhibited a flying machine which he called the June Bug He was immediately notified by the patentees that such machin with its movable surfaces at the tips of wings infringed the patent in suit and he replied that he di not intend to publicly exhibit the machine for profit but merely was engaged in exhibiting it for scientifi purposes as a member of the Aerial Experiment Association To this the patentees did not object Subsequently, however, the machine with supplementary planes placed midway between the upper and lowe aeroplanes, was publicly exhibited by the defendan corporation and used by Curtiss in aerial flights fo prizes and emoluments It further appears that th defendants now threaten to continue such use for gai and profit and to engage in the manufacture and sal of such infringing machines, thereby becoming an active rival of complainant in the business of constructing flying machines embodying the claims in suit, bu such use of the infringing machine it is the duty o this court on the papers presented to enjoin

"The requirements in patent causes for the issuanc of an injunction *pendente lite*—the validity of the patent general acquiescence by the public and infringement by the defendants—are so reasonably clear tha I believe it not improbable that complainant may succeed at final hearing, and therefore, the *status qu* should be preserved and a preliminary injunctio granted So ordered"

EXTRACTS FROM BRIEFS

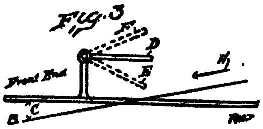
It would be impossible to abstract the briefs submitted in the Wright-Curtiss injunction suit A grea deal of space is taken up in Mr. Toulmin's brief i going into the history of aviation, and to the riddlin of A. M. Herring's affidavit to the effect that in 189 he made use of movable auxiliary surfaces.

The question of whether or not movable auxiliar surfaces, or popularly "wing tips," are infringement of the Wright patent seems to be uppermost in th minds of the aeronautical public Less attention ha been given the subject of prior art and the questio of the front rudder In the briefs the point as t whether it is necessary with the use of wing tips t turn the rear rudder to the high side is brought ou quite prominently.

Herring speaks in his affidavit of the necessity of adjusting a vertical tail whenever the angles of incidence of lateral tips are unequal He says In my 1894 gliding machine I found it necessary to use the vertical rudder in preserving a straight course, when I corrected the side equilibrium by using the auxiliary surfaces" This statement of Herring's seems to contradict the affidavit of Mr Curtiss in which he says in regard to his own machine "There is no necessity or reason for swinging the vertical rear rudder when the balancing rudders are swung because (as both balancing rudders are of the same size and area and present to the atmosphere the same angle of incidence) the resistance of the forward motion of the machine is the same for each rudder'

HOW EQUILIBRIUM IS OBTAINED

To explain the securing of lateral equilibrium in the Wright machine, for instance by increasing and decreasing the respective angles of incidence at opposite sides of the machine Mr Toulmin employs the sketch Fig 3 showing supplementary plane wing tip or marginal portion (*D*), "* * * and assume that there is another just like it at the far side This adjustment (*E*) will put the supplementary plane or margin at a greater positive angle of incidence than that of the main plane * * * If the distant supplementary plane or margin be adjusted up to the angle indicated at *F* its angle of incidence will have been changed from positive to negative * * * When however the two supplementary planes are adjusted at equal angles from position *D* taking up positions *F* and *F'* respectively it will be seen that with reference to line *B* from which the angle of incidence must be determined *F* is at one positive angle of incidence and *F* is at a negative angle of incidence less in degree *F* then offering the lesser resistance to the advance movement through the air The result would be that the side of the machine having the supplementary plane or margin *F* would advance more easily and with greater rapidity than the side having the supplementary plane or margin *F'* This would bring about an undesired turning of the machine from its intended course about a vertical axis Now then in the Wright patent this tendency of the machine to so turn on a vertical axis when the supplementary planes or margin are adjusted to effect a correction of careening or lateral tipping is compensated for by adjusting a vertical rear rudder which brings into action the compensating counter turning forces



The Wright brief goes on to state that in the Wright machine itself the rear corners of the main planes are adjusted simultaneously to equal angles from the normal or then inclination of the main aeroplane and that it follows from the explanation given in connection with Fig 3 the two adjusted marginal portions will have different angles of incidence to the line (*B*) of flight * * * and hence will offer different degrees of resistance at the respective sides of the machine ' This operation brings about the turning of the machine on its vertical axis and the giving to the right hand side a higher relative speed and tending to increase the lifting tendency of the right hand side even though the angle of incidence is inferior If this condition goes on unchecked the machine will lose its lateral balance entirely and is likely to tip edgewise and fall"

In flying the angle of incidence is stated to be constantly changing those changes being brought about by necessary manipulation of the front rudder

CONSTANT VARIATIONS IN ANGLE OF INCIDENCE

The Wrights say in an affidavit The angle of incidence in the main planes varies with every variation in the direction or force of the wind, with every variation in the power of the motor, with every variation of the path of the machine from a uniform line, and with every variation of the load This is explained as follows "Since in a flying machine the lift is equal to the total weight of the machine, it is evident that if the speed is increased a smaller angle of incidence will furnish the required lift while if the lift is decreased a larger angle will be required It is further evident that when two men are carried the angle will be greater than when one is carried, * * * moreover, when the power of the motor increases or decreases, the speed increases or decreases, * * * even with constant power the speed varies according to whether the machine is ascending or descending and the angle of incidence correspondingly increases or decreases" They also state that in an hour's flight the angle of incidence will be greater or less than a specified normal angle 59 minutes out of the 60.

Up to this point Mr Toulmin has avoided making any distinction between supplementary planes (or wing tips as popularly called) and the warping of the main plane itself The words 'supplementary aeroplane tip marginal portion supplementary plane or margin and wing are used interchangeably

In beginning a detailed discussion of the Curtiss machine attention is called by Mr Toulmin to the alleged fact that these adjustable margins constitute in effect portions of the aeroplanes (main supporting surfaces)

WING TILTING SAME AS WARPING

He says These marginal portions or tips of defendants machine are nothing more or less than parts of the main aeroplane set lower than the upper and higher than the lower main plane They are at the lateral extremities of the machine just as in complainants patent, they extend out beyond the more rigid part of the main aeroplanes just as in complainants patent * * * When either of them is at a positive angle it has a supporting function the same as do the complainants marginal portions The function of these is to maintain the lateral balance * * * while in flight and to control the right and left direction * * * in cooperation with the rear vertical rudder

The mechanical operation of the Curtiss wing tips is then described This information has been printed in Aeronautics and is well known so that it need not be repeated here

By the mechanical means the Wright affidavit says these marginal tips are under the immediate control of the operator and are adjustable to various and different angles of incidence to different angles relatively to each other and to different angles relatively to the main body of the aeroplanes That these marginal tips may be all the more in the nature of continuations of the main curved supporting surfaces or aeroplanes they are made of curved form with the concave side beneath * * * When these curved marginal tips are adjusted at equal angles of incidence the convex surface presented by the one will not receive the same horizontal resistance due to the wind pressure as will the concave surface presented by the other So this concave convex formation of these marginal tips produces unequal horizontal resistance at the opposite sides of the machine * * *

These margins constantly maintain different angles of incidence to the line of flight due to the constantly varying angle of incidence of the main surfaces to the line of flight * * * It will be seen that in defendants machine when one side tends to depart from horizontal balance * * * the operator immediately brings the machine back to normal equilibrium by throwing the marginal tip downward at the side of the machine which it dropped too low * * * and by raising the marginal tip upward at the side of the machine which is too high * * * In this way the lateral equilibrium is regained But the marginal tip with the greater angle of incidence while having a greater lifting effect will also produce increased drift or retardation of the speed of that side of the machine and, too the side with the smaller angle of incidence will likewise decrease drift or lessen resistance which will cause said side to run ahead of the other So the act of regaining lateral equilibrium tends to divert the machine out of course or to one side or the other And the accelerated speed of the side with the smaller angle of incidence also tends to increase the lift of that side and which if not checked would prevent maintaining lateral equilibrium It is here that the co-operation of the rear vertical rudder comes into important action This action consists in turning it, at this time so that it will swing to the side of the machine whose tip has the smaller angle of incidence, and thus will check the accelerated flight of that side and hold the machine to its true forward course without lateral divergence while the act of recovering later balance is in progress through the increased lift at the side where the tip has the greater angle of incidence That the operator in defendants machine can perform these operations he keeps himself constantly connected with the operating means by which these marginal tips and this rear vertical rudder are actuated For actuating this rear vertical rudder he utilized a hand wheel with which is connected the cable that extends to the rudder So when he shifts the yoke or cradle *G* with his body he likewise adjusts the rudder with the wheel to the extent required We state to the Court that such is the operation of defendants machine the disingenuous statements as to the rudder made in defendants affidavits not stating the real facts in regard to the uses of this rudder Mr Curtiss even says he can leave off the rear vertical rudder but we state to the Court that he has made no flight and could make none without the presence and use of this rudder as we here describe the same

Fig. 1

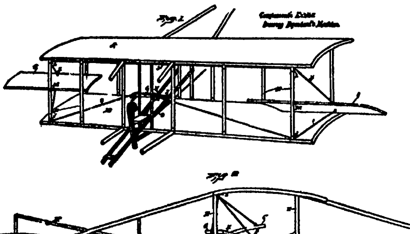
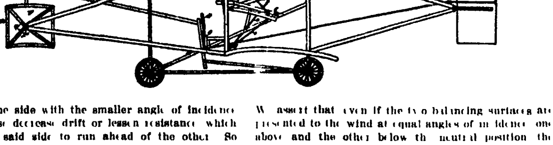


Fig. 2



Mr Toulmin continues The remaining feature of the defendants machine * * * is the forward horizontal rudder * * * The angle of the surfaces * * * can be adjusted to different angles of incidence so as to cause the machine to tend upward or downward and thus control its horizontal course This forward rudder cooperates with the adjustable tips *C C* in controlling the up and down direction while and at the time the horizontal balance is being controlled and also cooperates with the marginal tip should they be in a neutral position and thus tend to act as supporting surfaces

It now sufficiently appears that the mechanism mode of operation and result of defendants machine correspond exactly with the same disclosed in the complainants patent (Claims 7 11 and 1 cited and comparisons made with the Curtiss machine)

HERRING OUGHT TO KNOW BETTER

Alleging that the Curtiss side bases its contention on the theoretical assumption an assumption utterly without foundation in fact impossible in flight and contradicted moment by moment as defendants machine flies that the Curtiss machine in flight maintains one certain angle of incidence in which assumed position they say their marginal tips are at equal angles above and below the air pressure line Mr Toulmin flies a broadside of language when he says The defendant Curtiss knows better, the defendant Herring ought to know better and defendants counsel who acted as expert knows nothing about the matter

WRIGHTS CLAIM CURTISS WING TIPS CURVE

Referring to a blue print put in evidence by the Curtiss forces showing the defendants balancing rudders the Wright brothers testify Mr Curtiss is disingenuous in that he represents these balancing rudders as planes whereas in fact they are segments of cylinders having the convex side upward and concave side downward and are arched in the same direction as the main planes We have confirmed this fact by personal examination of the defendants machine

We assert that even if the two balancing surfaces are presented to the wind at equal angles of incidence one above and the other below the neutral position the convex surface presented by one will not receive the same horizontal resistance as the concave surface presented by the other and the aeroplane will tend to turn about a vertical axis

Mr Curtiss assumes that the so-called normal position of the balancing rudders from which they are adjusted equal distances in opposite directions up and down is always in line with the direction of the machine through the air and therefore in line with the relative wind This is a false assumption

(To be continued)

AN INTERNAL-COMBUSTION PUMP.—II.*

APPLICATIONS OF A NEW PRINCIPLE.

BY HERBERT A. HUMPHREY.

Concluded from Supplement No. 1780, Page 103

ciency Tests.—The first experiments were car-d out at Brimsdown, but in the early part of 1908 a ding station especially designed to facilitate the ting of the pumps was erected on the ground belong, to the South Staffordshire Mond Gas Company at dley Port. Mond producer gas, electric current mpressed air and a good supply of water were all vailable at the site chosen, and the plant erected by he Pump and Power Company, which controls the uthor's patents, is illustrated in Figs. 11 to 14 annexed. The building for containing the pump is fitted vith an overhead crane for lifting off the cylinder over of the pump and demonstrating how quickly the ew working parts can be changed. The pump itself s shown, and the delivery main passes into an air essel upon which any pressure can be put by means f compressed air. The outlet from the air vessel is onnected to the measuring tank, which contains perorated baffle plates to steady currents, and in the ottom of the tank is fixed a casting which receives ny one of a number of accurately made sharp-edged rifices through which the water flows into the large ater stock tank below. An accurately graduated gage s fixed close to the orifice to show the height of the urface of the water above the sharp edge of the orice, and when the height and the size of the orifice re known, the quantity of water passing through the easuring tank can be readily ascertained through e well-known formula

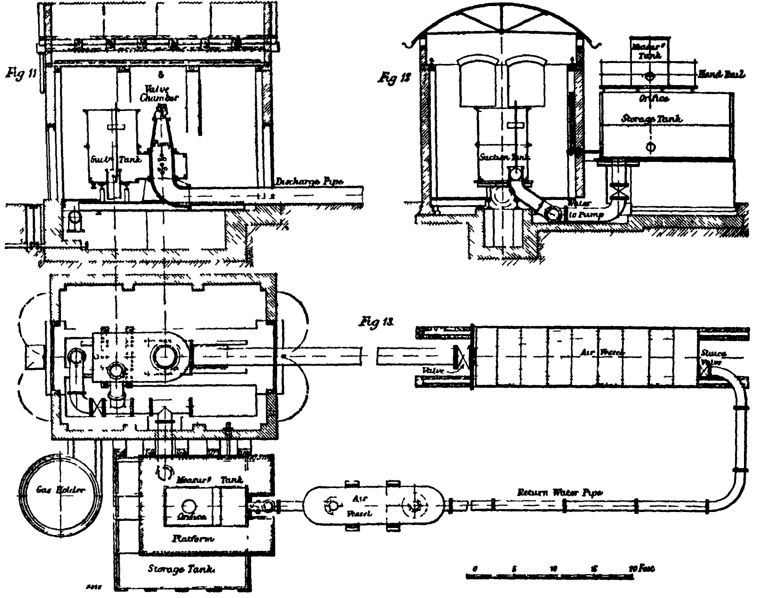
Gallons per second $= 6.24\,k\,A\sqrt{2gH}$

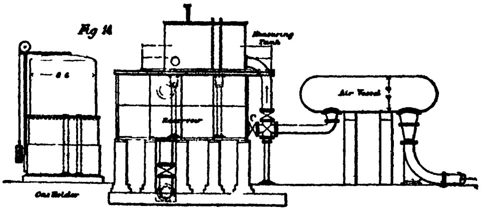
Where k = coefficient of contraction of orifice,
A = area of orifice in square feet,
H = head over orifice in feet.

The stock tank is connected by an 18-inch pipe to the uction tank of the pump, and thus the water is merely irculated over and over again. Between the air vessel nd the measuring tank there is a valve, so that the ow is throttled at this point in order to maintain the quired pressure in the air vessel, and pipe connecions are brought from the air vessel and the suction nk respectively to the two sides of a U-tube containing mercury, so that the actual lift of the water can be measured on a properly graduated scale.

The gas holder for measuring the gas was specially constructed for test purposes. A calorimeter for obtaining the heat value and the usual appliances for analyzing the gas and burnt products are included in the equipment.

GENERAL ARRANGEMENT OF PUMPS AND CONNECTIONS (FOR TESTING PURPOSES)





Many tests of efficiency have been made with the plant described, and an official test of a four-cycle Humphrey pump was carried out by Dr. W. Cawthorne Unwin, F.R.S., and his assistant at Dudley Port on September 21st and 22nd this year. A summary of Dr. Unwin's report is added as an appendix, and the results show that with a pump of only 16 pump horse-power the consumption of anthracite coal is 1.06 pounds per pump horse-power hour. This is about half the coal consumption of the highest class of steam pump, and is also considerably less than with an ordinary gas engine driving any kind of pump on the same water lift. With slack costing 6s. 9d. per ton delivered into the Mond producers, the actual cost of slack to yield the 83 cubic feet of gas mentioned in the report per pump horse-power hour is under 0.06d.

Experiments have shown that the pump works extremely well with gasoline supplied through a carbureter, and gives about the same thermal efficiency as when working with Mond gas, but the water delivered from the pump is considerably increased. Water gas has also been tried, with equal success, but so far neither ordinary town gas nor paraffin has been used. Probably ordinary paraffin in conjunction with a separately heated carbureter would form a useful working medium for isolated or contractors' pumping plants.

All the experiments so far have been confined to pumps in which an explosion takes place on ignition, but the author has designed a pump in which the combustion takes place at constant pressure.

Thermal Efficiency.—It has already been mentioned that theoretically the pump cycle is superior to that of the Otto gas engine, or of any other gas engine in which the volume of the expanded products is the same as the original charge volume. In Fig. 15 a curve is drawn showing the theoretical pump-cycle efficiency, assuming that the maximum temperature reached on combustion is 1600 deg. C. Another curve is drawn assuming the maximum combustion temperature is 1000 deg. C. Using Mond gas and low-compression pressures the second curve more nearly represents the true state of affairs, but as the compression pressure increases the combustion temperature is also increased, and the first curve is approached. Consequently a curve drawn as shown in dotted lines between these two curves, and passing from the lower to the higher of them, fairly represents the correct theoretical efficiencies when using producer gas.

This dotted curve has been transferred to Fig. 16

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* Paper read before the Institution of Mechanical Engineers, Novem- er 19th, 1909.

below), and plotted against it is the efficiency curve r the Otto cycle gas engine, assuming the working edium in both cases to be air Mr Dugald Clerk s shown that the possible efficiency which can be alised in commercial gas-engines of fairly large size about 71 per cent of the air standard, and assum g that this ratio also holds good for the pump cycle e arrive at the two curves given in Fig 17, in which e attainable efficiencies are compared It will be oted that although the pump cycle curve is always ove the Otto-cycle curve the efficiencies of the pump e greatly in excess of those of the Otto engine at w compression pressures This is much to the advantage of the pump because it enables a good commercial efficiency to be obtained with relatively low orking pressures

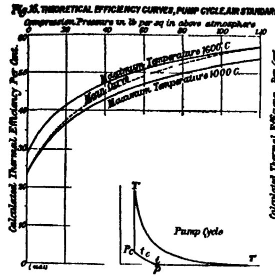


Fig 15 THEORETICAL EFFICIENCY CURVES, PUMP CYCLE AIR STANDARD

Formulæ for Pump Cycle Diagram

$$\text{Efficiency} = 1 - \gamma\frac{T^1 - t}{T - t_c}$$

$$T^1 = t\left(\frac{T}{t_c}\right)^{\frac{1}{\gamma}}$$

$$= t\left(\frac{p_c}{p}\right)^{\frac{\gamma-1}{\gamma}}$$

T = (for curve at 1000 deg Cent.) = 273 + 1000 deg Cent = 1273 deg Cent. absolute
T = (for curve at 1000 deg Cent.) = 273 + 1600 deg Cent. = 1873 deg Cent. absolute
γ = 1.408.
t = Suction temperature = 17 deg Cent. = 290 deg Cent. absolute

Adiabatic compression and expansion

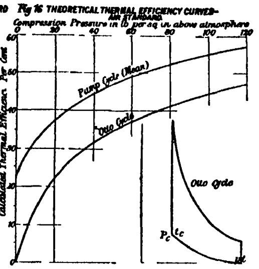


Fig 16 THEORETICAL THERMAL EFFICIENCY CURVES—AIR STANDARD

Formula for Otto Cycle Diagram.

$$\text{Efficiency} = 1 - \frac{t}{t_c}$$

t = 273 + 17 deg Cent. = 290 deg Cent absolute

$$t_c = t\left(\frac{p_c}{p}\right)^{\frac{\gamma-1}{\gamma}}$$

γ = 1.408

Fig 17 PRACTICAL EFFICIENCY CURVE 0.71 OF AIR STANDARD.

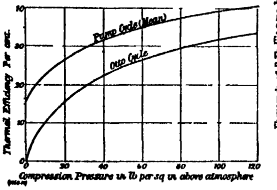
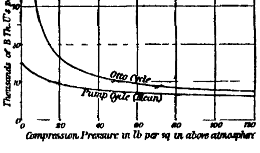


Fig 18 BRITISH THERMAL UNITS PER I H P HOUR CALCULATED FROM 0.71 OF AIR STANDARD

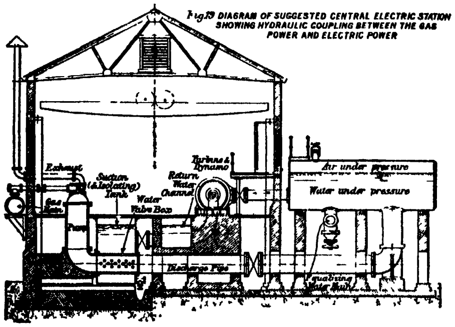


In Fig 18 the results of Fig 17 are translated into ritish thermal units per indicated horse-power hour, that with any working medium of a given calorific alue it is possible to see how the gas consumption aries with different compression pressures

Application for Power Purposes—The curves just entioned are specially interesting because they lead e to recognise the possibility that as the author's ystem comes to be developed in the future, internal ombustion pumps may be substituted for gas engines central electric power stations If the water pumped passed through an ordinary water turbine driving an electric generator and the water is then returned to the pump to be used over and over again we arrive at a gas power electric system with the water forming an hydraulic coupling Even now the combination of the author's pumps with water turbines gives far greater economy than that reached by an internal combustion turbine so far constructed It is of course dangerous to prophesy but there is no harm in looking so far ahead into future possibilities in order to see what a central station on the new lines might be like

Fig 19 (annexed) shows in diagrammatic form a section of such a central station so as to exhibit one unit of plant the other units being arranged side by side The pump discharges through the valve box situated in the suction tank This tank also serves as an isolating tank The discharge pipe conveys the water into a large air vessel placed outside the building This air vessel is connected with other similar air vessels by a common air pipe at the top which maintains the air pressure the same in all vessels and a common water main at the bottom The water is fed to the turbine by a pipe and the turbine discharges into a longitudinal canal which has a connection to each of the suction tanks The turbine is direct coupled to the electric generator and the current may be taken to the switchboard which is conveniently placed for overlooking the machinery The necessary isolating valves are shown and it will be noticed that the working parts of the pump as also the turbine and generator are so situated as to be supervised from a common platform The gas main runs longitudinally outside the building

Fig 19 DIAGRAM OF SUGGESTED CENTRAL ELECTRIC STATION SHOWING HYDRAULIC COUPLING BETWEEN THE GAS POWER AND ELECTRIC POWER



The advantages of such an arrangement are fairly obvious and arise chiefly from the simplicity of the working parts the absence of noise and shock and from the exceedingly low cost of upkeep In gas-engine stations using cheap producer gas or blast furnace gas the cost of lubricants and stores frequently exceeds the cost of the fuel but in the present instance there is practically no lubrication required and the author has worked one of his pumps for a week at a time with absolutely no lubrication whatever Of course one has to face the loss due to the conversion of the water power into mechanical energy but the efficiency of a well designed turbine is not less than 80 per cent at full load and there is no need to work any of the pumps at less than full load The ease with which the pumps can be started and stopped from the switchboard gives the electrician complete control of his station and the ability to start up one or more pumps at a moment's notice In fact even this arrangement can be simplified because the governing of the pumps can be so arranged that a steady pressure is kept on the air vessels irrespective of the demands and a slight rise in this pressure may automatically cut out one pump and its attached dynamo after another and restart them again as the pressure falls Based on the efficiencies so far obtained a Board of Trade unit can be generated for [illegible] pounds of anthracite coal and with the large units of plant required in central stations this figure should be much reduced Even if the fuel economy should not prove to be higher for such a station yet its other advantages may more than compensate for this defect One other aspect of this question might be mentioned and that is if the contour of the district is such as to permit the construction of a high level reservoir of considerable capacity in proximity to the pump house water can be pumped into this reservoir and be drawn

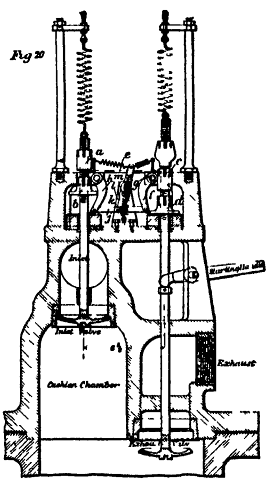
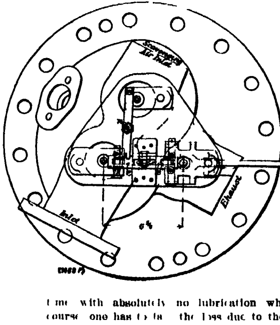


Fig 21 PLAN OF CYLINDER TOP (Fig 20)



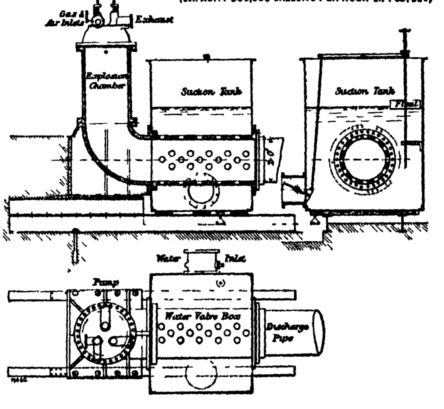
upon as required. This would enable the pumps to work steadily day and night on a 100 per cent load factor and would reduce the quantity of plant in so far as the gas producers and pumps are concerned to the minimum possible.

If the internal combustion pump proves in the future to be a successful competitor of the gas engine for power purposes then it is probable that one of the most useful fields for its employment will be found in the propulsion of ships. Quite apart from the possibility of driving a turbine attached to a screw propeller there is the much more efficient jet propeller which is the most efficient of all propellers for ships if properly constructed and operated. What has been lacking so far has been a type of pump capable of delivering large quantities of water at comparatively low heads and it is just these conditions which suit the author's pumps in their simplest form. It would carry us too far to follow up this line and one must be content with merely throwing out the suggestion especially as the short time remaining must be devoted to the description of some details of the pump.

Pump Details. In all the diagrams except the first the mechanism which controls the valves has been omitted but in Figs. 20 and 21 some details are presented. These figures represent a recent design of valve chamber suitable for either a two-cycle or four-cycle pump the curious fact being that exactly the same mechanism serves for both cycles. During the experiments precisely the same pump and gear was by altering the conditions made to operate on either cycle at will. In the figure three valves are shown the admission valve the scavenging valve and the exhaust valve. The last mentioned valve is situated at a lower level than the others and above this valve is situated the cushion chamber which also forms part of the explosion chamber in which the charge is compressed before ignition. The valve stems each carry top and bottom circular nuts *a b c d*. The latter serve to limit the opening of the valve by coming in contact with the rubber buffers and the top nuts serve to lock the valves in their closed position when the bolt *e* slides between the underside of the nut and the top of the brackets. The remaining gear will be sufficiently understood if its operation is described. Starting with all the valves shut ignition occurs followed by expansion. The locking bolts are at this time in such a position that the admission valve is locked and the exhaust and scavenging valves are free to open. The expansion is rapid and as the point of atmospheric pressure is passed suction causes the exhaust valve and the scavenging valves to open simultaneously. In the exhaust pipe there is a light non-return valve placed so that it is normally closed. This prevents the suction from drawing back exhaust products and causes a rush of air past the scavenging valve into the chamber so that the top portion of the chamber is well swept out. The suction is soon over and the water column beginning to return the scavenging valve shuts under the action of its spring but the exhaust valve remains open while the products are discharged. When the water reaches the exhaust valve it shuts by impact and the cushion and cushion expansion strokes followed by the suction stroke results. It will however be seen that when the exhaust valve shuts the enlarged portion of its lower nut bearing against the curved lever *f* which is hinged at *g* forces this lever to the left. As another curved lever *h* is hinged to the first lever by means of the link *i* this other lever has also to partake of the motion and move to the left thus setting it in position to be acted upon by the lower nut on the inlet valve. Link *i* carries a pin *k* which engages against a lever *l* hinged at *m* in such a manner that when link *j* moves to the left the top of lever *l* moves to the right. Two springs are shown attached to lever *l* that on the left being stretched and that on the right being closed and as these two springs act upon the bolt *e* in the position shown the effect is to urge the bolt to the right. This bolt cannot however move until the top nut *c* has risen to its full height which occurs when the exhaust valve shuts. The movement of the bolt then takes place and locks the exhaust shut at the same time releasing the admission valve. Consequently when the cushion expansion stroke is followed by the charging stroke the suction opens the admission valve and a fresh charge is drawn in. The opening and shutting of the admission valve reverses the action of the gear locks the admission and unlocks the exhaust ready for the next cycle. It should be explained that the bolt which controls the scavenging valve is pivoted at *n* Fig. 21 and has one end fastened to the bolt *e* so that this end partakes of its motion. Whether the rise and fall of liquid which drives out the products and takes in the fresh charge is due to an oscillation of liquid between the supply tank and the chamber as in the two-cycle pump or is due to a reversal of flow in the discharge pipe as in the four-cycle pump makes no difference to this gear.

The only other working part is the water supply valve which of course is purely automatic in its action. A single valve as illustrated in the diagrams would need to be too large and heavy to be practicable except for small sizes of pumps. Consequently the single valve is replaced by a number of valves. An arrangement which the author has found very effective is shown in Fig. 22 where a cylindrical valve box is pierced by a number of holes each fitted with a simple gun-metal valve held on its seat by a light spring. In Fig. 22 the valve box is shown as placed immediately after the pump and so virtually forms part of the discharge pipe. One very interesting fact should be noted in connection with the water valves. Each valve is normally held closed by a spring of such strength that it readily allows the valve to open when suction occurs. Now suppose that one or more of the water valves is fitted with an attachment which alters the compression of the spring so that the spring no longer brings the valve to its seat under normal conditions. The valve or valves thus fitted do not shut with the other valves but water flowing through them causes them to shut under the action of the velocity. The result of such an arrangement is important because it allows the pump to keep on working even if no explosion occurs. Thus if a charge contains too much gas or air and fails to explode it will expand again after compression and be exhausted and a fresh charge drawn in the pump continuing to work at the expense of a small quantity of energy representing the amount of water which falls from the high to the low level and escapes past the water valve mentioned. It is not usually desired that this should be a normal condition of affairs but it is useful at any moment to be able by moving a lever to keep the pump running without explosions. By purposely exaggerating this action and suitably altering the inlet and exhaust valve mechanism the pump may be converted into an air-compressor for compressing air by the energy of falling water.

Fig 22 PUMP AS DESIGNED FOR THE BRUSSELS EXHIBITION (1910). (CAPACITY 250,000 GALLONS PER HOUR LIFT 35 FEET)



In concluding this paper the author wishes to express his indebtedness to those of his assistants who have taken an active share in the development of the pumps and especially to Mr W. J. Rusdell who has taken the keenest interest in the experimental work and who originated the suggestion that the cushion stroke instead of being produced by an oscillation of the supply water should be caused by a reverse flow in the discharge pipe thus making the two-cycle into a four-cycle pump. Mr Allen Nicholls B.Sc. has had charge of the electrical ignition devices and has succeeded in producing a sparking plug which is absolutely reliable when washed by water at each stroke.*

In commenting on Mr Humphrey's paper, London Engineer critically observes:

Of the future of Mr Humphrey's pump it is as yet too soon to speak with certainty. That it works and works well in the sizes that have already been made there can be no question all who have seen it in operation being definite as to the ease and certainty with which it acts. But when the inventor asks us to take long strides into the future and see his pump being used for the driving of central power stations and the propulsion of ships we are disposed to think he is hurrying too fast. It is a long way from 16 horse-power to 10 000 and on the road many unexpected difficulties must be encountered. Mr Davey in an excellent critical review of the paper pointed out some of them and particular attention may be directed to his estimate that to pump against a head of 200 feet Mr Humphrey would require a pipe certainly not less than 600 feet long. Now the construction of a pipe of that length, and 2 feet or 3 feet in diameter, to withstand a high pressure is no light thing to enter upon. Where circumstances permitted it to be straight the difficulties would be great enough, but if in order to economize space it had to be returned or coiled upon itself they would be multiplied many times. We are far from saying that mechanical skill could not meet and overcome the difficulties, what we do say is that it is too early even to consider such things and that years of experience with lower lifts must be passed before high lifts should be attempted. And indeed Mr Humphrey has no need to trouble about high lifts for the present, for his pump with an efficiency greater than that of any other water raising device at low heads should have a future before it for irrigation water supply, sewage pumping and so on which should be enough to satisfy the inventor. But even for these purposes although there can be no question about the mechanical operation of the apparatus there are other questions which must be satisfactorily answered. For example, if potable water is pumped will it as Mr Bryan asked be injured by the absorption of some of the products of combustion? The combustion of ordinary gas is accompanied by the production of sulphur dioxide which is readily absorbed by water. Does the water delivered by the gas pump show signs of this? We have raised this point with Mr Humphrey and he assures us that he has been unable to trace any acidity in the water leaving the pump. That is favorable as far as it goes. Then again though there may be no acid is there any fouling of the water by tarry and oily products? Again Mr Humphrey replies in the negative. But the tests have been, so far, made on a very limited scale, and before a definite decision on such an important point can be given a close investigation will be necessary. These things however, would not affect the value of the pump at all for dealing with sewage, and probably for irrigation either, but for the latter the inventor has quite another problem before him. A great deal of irrigation pumping is done by oil engines in districts where the production of gas is practically out of the question. Can Mr Humphrey operate his pump on the lines of the oil engine, and, if so, will the products of combustion still remain innocuous?

These are but a few of the practical considerations that will have at some time or another to be faced but they do not affect in any way the fact that Mr Humphrey, having in a most ingenious manner removed all the intermediary gearing between his power and the material that power is to act upon, has produced a pump which is free from the bulk of the mechanical losses to which ordinary pumping engines are subject. His pump has all the thermal efficiency of a gun in that the explosive acts directly upon the projectile to be expelled. That the superiority of the thermal efficiency claimed by Mr Humphrey may and will be challenged we do not doubt and we are not surprised that Mr Davey on the one hand, as the champion of steam pumping has protested against the unconditional statement that the best pumping engines required 18 pounds of steam per pump horse-power—the head should be stated—and on the other hand that Mr Irwin as a champion of the ordinary internal-combustion engine should claim an equal efficiency with Mr. Humphrey.

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* The paper was accompanied by an appendix giving a summary of Dr Unwin's report.

LEONARDO DA VINCI.—I.

THE ENGINEER AND MACHINIST.

BY EDWARD P. BUFFET.

The wise beware of superlatives. To pronounce any man or any machine "the greatest" or "the best" is a presumption which invites contempt. Were the question asked "Whose is the most exalted genius that the world has known?" it would sound like an idle riddle to be answered according as the hearers preferred various qualities that enter into a genius. Few Americans, in any event, would cite the name of Leonardo da Vinci. Yet none can examine the relics of that mysterious Florentine without finding proofs of an intellect beside which those of Cæsar and Shakespeare dwindle to meanness.

Leonardo's reputation is well enough established as a painter in a class with Michael Angelo and Raphael, but his name strikes the ear with little suggestion of gifts other than those of a pictorial artist. Yet this was only one manifestation of a mastership which comprehended every branch of art, science and industry.

No other man ever came near him as a universal genius. None ever had half so many specialized brain cells. In several of his activities independently he is a strong claimant for premiership of excellence, while the combination of his accomplishments makes his superiority overwhelming.

To any mechanic it must be a ground of pride that the artist hand which endowed the Italian Renaissance with works second perhaps in merit to those which remain from the age of Phidias should have busied itself no less eagerly with tasks of engineering and machine design. As a creative power in mechanism the rank of da Vinci is not secondary, but incontestably he is entitled to first place in history.

As we turn over the vast collection of sketch books left by Leonardo, filled with assembled machines and details roughly outlined like the commonplace notes of any present day designer, yet enlivened with a grace and confidence of stroke, an expressiveness of meaning such as no other draftsman ever gave, there arises a feeling almost of awe and a conviction that nothing which may help us to understand the personality of such an engineer can be without value for his modern fellow craftsmen.

LEONARDO'S MULTIFARIOUS WORKS.

In science and technology he was a true prophet, both as a foreteller and a forthteller. So little is known of the mechanical proficiency in his time that we cannot be sure how much of his work was founded on that of others and how much was original. But it is certain that he forecasted the years which were to come after him, outlining the progress of the future by notes and sketches, most of which remained hidden away while other men won fame by puzzling out singly the problems that he had solved *en masse*.

Of the achievements ascribed to him some may rest on tradition or inference, but very many are amply attested by his own hand. Without pausing to discriminate sharply as to the respective evidence for them, a partial summary of his alleged accomplishments may be given at this point.

Leonardo anticipated Copernicus in forming a just conception of planetary motions. Before Newton he apprehended the principles of gravitation, he was familiar with the laws of motion. He was aware that the earth revolved, he attributed the tides to solar attraction. Like Galileo, he discovered earth shine on the dark of the moon, he also perceived the burnt out condition of that satellite. He noted that the apparent size of the stars increases toward the horizon, and he distinguished their scintillation as a phenomenon independent of themselves. He established the relation between the dilation of the eye pupil and the intensity of light. He speaks of "constructing glasses to see the moon large," a single lens though this may be. He is credited with making also a camera obscura. It is said that he invented the barometer afterward realized by Torricelli and directed his studies toward the thermometer, for which Galileo has received honors. He likewise conceived a hygrometer, a compass with movable center and a most improved form of the balance.

While yet Harvey was unborn Leonardo observed the circulation of the blood. Before Darwin he found in the horse rudimentary muscles and unused organs—a "water stomach." Centuries before Cuvier he reconstructed extinct animals from fossil remains. There have been ascribed to his perception the molecular composition of water, the motion of waves and the undulatory theory of light and heat. Not only was he skillful in the practice of music, but adept in the theory of acoustics. He built musical instruments on scientific principles, observing the transmission of sound waves in space. He studied the echo and its angle of production; in times of tempest he measured sound velocity.

He studied combustion and called smoke fire without air, thence inferring that fire feeds on air. He investigated the possibilities of steam power and designed a steam cannon. Steam pumps seem also to have been in his mind. Moreover there is one of his sketches which, though obscure, has been thought by some to indicate a steamboat.

Mathematics he followed far and made many geometrical discoveries. He studied the formation of the regular polyhedrons, he was the first in Italy to employ plus and minus signs. One of his myriad mechanical investigations was concerning the power of a lever moved on an inclined plane.

In hydraulics alone he did enough to furnish fame for several men. Until he arose, so far as we know, that branch of physics had been neglected from antiquity. His canal irrigation and harbor engineering gave him plenty of opportunities for applying it. Thus he had occasion to solve such problems as the quantity of water required to fill a certain canal and the length of time it should run. In recondite diagrams he depicted the contours of different jets issuing horizontally from orifices. A mill pipe he found is not filled by parallel threads of water, but by periodic eddies or currents, the vertical axes of which shift their position.

Many were his inventions relating to this favorite element water. Pumps of complicated design occupy large space in his books. He designed novel buoys, diving apparatus and the first life-preserver. Among the earliest canal locks were his. His drawings display dredges of different types and gigantic machines which were to be advanced along the canal bed for systematic digging on both sides.

Liquids were not the only fluids that he studied, but his researches extended to the gaseous realm. Thus he treated the resistance or pressure of the air as dependent on its weight. He measured its density, and as already mentioned, he devised the most important meteorological instruments. His elaborate work in the study and imitation of wings should be classed rather with mechanics than with pneumatics. For he displayed great ingenuity in the design of flying machines, ornithopters and helicopters. He also knew the use of the parachute.

In Leonardo's industrial machine designing there is most of marvel. Mechanical details that never would be ascribed to the beginning of the sixteenth century and complete apparatus of infinite variety and purpose luxuriate in his huge note books. Cams, levers, gears, worms, ratchets, sprockets and chains abound in almost every pattern, ancient or modern. We find rolling mills, draw benches, power hammers, cranes, shears, threading machines, file cutting machines, rope making appliances, and metal or wood working tools, such as lathes, planers, boring mills, boring jigs, self-centering chucks, bending machines and broaches. A stone cutting saw of his invention is still used in the Carrera marble quarries. He was far advanced in the use of automatic machinery for needle grinding, gold beating and other purposes. He planned many patterns of radius grinders for use in the manufacture of concave reflectors.

During the Medicean age Florentine fabrics were celebrated. It was therefore natural that some of Leonardo's most recondite designs should appear in textile machinery. He laid out a complicated multiple cloth cutter, a gig, looms, etc. Yet in da Vinci's time, as in our own, the constructive arts were largely subservient to those of destruction. Military engines engrossed an inordinate share of his attention. Those which he designed follow a line of contact between ancient and modern warfare. On the one hand are catapults, ballistas, huge crossbows bent with windlasses, and instruments for scaling and battering down fortress walls. On the other hand are breech loading cannon, divers types of artillery carriages, various forms of multiple barreled guns. He laid out machines for drawing and rolling iron staves used in artillery manufacture, and he shows a thorough knowledge of foundry practice. He studied also the composition of explosives. Whether he invented any instruments of torture is not disclosed by a superficial examination of his books, but if he did he found a ready market for them in Italy of his day.

It is hardly necessary to add that Leonardo dabbled in chemistry, particularly in the mixing of pigments, and it is only candid to admit that along this line his results did not uniformly add luster to his reputation. The skill which generally he displayed therein is obscured by certain spectacular failures, much detrimental to his artistic output, as will appear from the sketch of his life hereinafter following.

To prolong adequately this bill of particulars would lead us far into architecture, geology, botany, zoology, anatomy, linguistics, and indeed over nearly all the fields of human knowledge. As has well been said, Leonardo combined the artist's gift of creation with the mechanical inventor's ingenuity and the philosopher's passion for truth. In the third of these characters, as well as the first two, he was gifted to shine; his recorded reflections entitle him to rank as a philosopher; his critical epigrammatic writings and his attributed poetical compositions do him credit in the province of literature.

THE MAN, HIS HEREDITY, HIS ENVIRONMENT.

Heredity can no better account for Leonardo than for a white crow. Born 450 years ago (1452) as the natural son of an undistinguished notary and a peasant woman, he entered the world well favored to perfection physically and mentally, an anticipatory instance of the superman.

In no way does he appear more to advantage than as tested by that exacting Aristotelian judgment which holds excellence to reside not in essence, but in proportion, which regards as good or bad that which is fitly or inordinately blended. His moral qualities, like his talents, were tuned to harmony. Reticence and geniality, meekness and self-assertion, peacefulness and belligerency, orthodoxy and heresy, beauty and utility, theory and practice were adjusted to the finest poise. The sanity of his mind was Grecian, yet better than Grecian. It was that sanity which caused him, a century before Francis Bacon, to let in the daylight of modern applied science.

While no man ever made better use of his opportunities than da Vinci, no one ever lived whose opportunities were better. Standing where he did at the meeting point of the ages, he was permitted to do what no engineer had so freely done before, what no engineer can do now or hereafter, to bring forth out of his storehouse things new and old.

We study ancient history to gratify curiosity or human interest, but we have pressed so far beyond it mechanically that no chance is left of finding anything in it that can help us technically. In literature read nothing new, in science read nothing old. But when Leonardo came the richest scientific wisdom was in a treasure house of antiquity, where it had remained undisturbed for over 1,000 years, waiting for him to open the door and make it all his own.

Little vitality had moved in physical learning since the ages when fleets of republican Rome had been enkindled by mirrors of Archimedes, when his analysis had fathomed the dynamic mysteries of water, when Heron's fountains had played in laboratories of Alexandria and the oil of Carthaginian olives had flowed from Cato's cunningly contrived presses.

Already for a thousand years the dwindling traditions of secular knowledge had been severed in the West by the fall of the empire, and since then little care was given to any but superstitious letters. Applied science could scarcely flourish where pure science was abhorred. Chemistry, physics, mathematics, astronomy were regarded as black arts, and books upon them were burned with the authors, whose condemnation for sorcery, if their intent sufficed, was often not unmerited. Booklore, aside from this, was made up of unprofitable subtleties concerning the dreariest of dogma.

Influences to a revival of learning came not only through chance acquisitions from the East in the Crusades, but through pupilage to the cultured Saracens of Spain, from whom Latin scholars gratefully received algebra and medicine at the universities of Cordova and Toledo. But the new life was directly ushered in by the fall of Constantinople, which drove into western Europe the savants of the Greek empire, with their feebly understood but still cherished manuscripts of the old philosophers. This occurred a year after the birth of Leonardo, who thus became heir of antiquity.

EXPERIENCE AND UTILITY.

Francis Bacon is credited with having established the modern policy in science. A hundred years earlier Leonardo da Vinci had laid down that policy and had constantly acted upon it.

Every school boy knows that the novelty introduced by Bacon was inductive reasoning, but every school boy knows something which is not so, for men have always reasoned inductively; the oyster reasons inductively when he learns that opening his shell lets the water in Rather, as Macauley has pointed out Bacon's revolution consisted in turning men from speculation to objects that could be attained only by induction and by induction carefully performed. The keywords of his doctrine were utility and progress

Usefulness was despised even by the best and wisest of the ancients. Seneca, the stoic tutor of Nero, rejected as an insult to philosophy the notion that she could have taught the use of metals or improved a ship, plow, or mill He sought to disprove, as shameful slanders, that Democritus had designed the arch and Anacharsis devised the potter's wheel "In my own time,' he said, 'there have been inventions of this sort, transparent windows, tubes for diffusing warmth equally through all parts of a building, shorthand, which has come to such a perfection that a writer can keep pace with the most rapid speaker But the invention of such things is drudgery for the lowest slaves, philosophy lies deeper It is not her office to teach men how to use their hands"

Socrates had praised astronomy because its effect is to raise the mind to the region of pure truth Plato valued arithmetic chiefly for the same reason and he rebuked Archytas for constructing high power machines on mathematical principles since this degraded a noble intellectual exercise into a low craft, fit only for carpenters and wheelwrights Even Archimedes was ashamed that the creations of his genius clothed themselves in matter

Such were the influences which freed Leonardo's generation from the still more impractical scholasticism of the Dark Ages in which it had been produced, but he was bound no more by classicism than by Medievalism, with the force of his instinct, he burst out to the wider liberty of modernism

It was creditable for Bacon in the Elizabethan era to declare that trees of learning must be judged by their fruits—not merely by their flowers and leaves—but long before him da Vinci had remarked

"Mechanics are the paradise of mathematics, because here we come to the fruits of mathematics"

(To be continued)

SCIENCE NOTES.

In view of the recent researches as to the action of various rays upon precious stones such as the amethyst or beryl, M Paul Sacredote notes the effect in the case of the diamond This is of interest seeing that its chemical constitution is simpler than the others and also that the least changes of color will vary the commercial value of the diamond He used diamonds from different sources, some of them colorless and others having a slight yellowish tint and he examined them in turn by the action of the X rays, with the stone placed outside the tube, also by the cathode rays with the diamond inside the tube, and lastly by the action of heat The diamond is placed inside a muffle of refractory earth with electric heating, while a thermometer shows the temperature up to 300 deg C He finds first that the action of X rays does not change the color to any noticeable extent Second, the cathode rays modify the color of the diamond considerably, and the initial hue, white or very light yellow, becomes darker by degrees and takes a light brown tint and this becomes dark brown by prolonging the action The diamond thus colored appears to keep its hue, since the sample he showed to the Academie des Sciences was prepared about a year ago It was kept in a box, but at times exposed to the light and on one occasion it was left for an entire day in sunlight As to the action of heat, from 300 to 400 deg we find that heat has a decolorizing action so that we can bring back a colored diamond to its initial hue in this way

The genesis of a new idea is so difficult, and the amount of work necessary for its complete elucidation and development so vast and detailed, that many eminent men taking only a short period of time and not realizing the minute steps by which the advance of knowledge takes place have been led to doubt the value of scientific investigation in the higher realms of pure knowledge, even to the extent of speaking of the bankruptcy of science Others, again, perceiving the apparent aimlessness of many investigations and undervaluing the motive which urges them on, have come to look with a certain contempt upon the man of pure science and his slow and plodding progress What is the good of all this work at unimportant details? What do you get out of it, and what pleasure do you find in it? they ask and when they are told that the humble worker usually gets nothing out of his work except the pleasure of doing it and that his motive is nothing more elevated than the satisfaction of his curiosity, there does appear to be, it must be admitted, some justification for the contemptuous indifference with which the poor researcher is regarded by a considerable section of the population It is impossible to organize research on a commercial basis. "All attempts," says Prof Nichols, of Cornell, "at a machine made science are doomed to failure No autocratic organization is favorable to the development of the Scientific Spirit No institution after the commercial models of to-day is likely to be generously fertile You can contract for a bridge according to specifications No one, however, can draw up specifications for a scientific discovery No one can contract to deliver it on a specific day for a specified price, and no employee can be hired to produce it for wages received."

ENGINEERING NOTES.

Bricks and blocks of stone have been manufactured for some years past from a mixture of sand and lime, but little is generally known concerning their strength and durability In a short paper by Mr J C Stead, which has just been published in the Journal of the Society of Chemical Industry, some of the troubles experienced in the manufacture of large blocks of stone from sand and lime are described, and the faults liable to be found in such stone are mentioned It is shown that under certain conditions sound stone can be produced on a large scale, but we think that the impression conveyed to most readers by the paper will be that large blocks of artificial sand lime stone are liable to vary greatly in strength and durability, and that they should not be used in positions of importance The stone discussed by Mr Stead was made by placing a mixture of sand and quicklime in moulds and subjecting the mixture to the action of steam or hot water under a pressure gradually rising to nine or ten atmospheres The mixture was then cooled, removed from the moulds, and used without further treatment Mr Stead's tests show that with a mixture of about 13 5 per cent lime with 86 5 per cent sand it is possible to make stone which will bear a load of over 9,000 pounds per square inch, but with higher and lower proportions of lime the results were not so good

During the construction of the Pennsylvania Railroad tunnel a deviation from the correct line, apparently caused by a misdirected blast, caused a cavity extending some 3 feet beneath the foundation of the Cambridge Building at the corner of Fifth Avenue At the same point part of the roadway collapsed, and although the interior cavity was filled in and made secure as far as possible, the road footpath and the building affected continued to settle In the proceedings of the American Society of Civil Engineers Mr T Kennard Thomson describes in detail the injuries caused to the building and various interesting facts brought to light by his investigations into the character of the old pile foundations and the nature of the subsoil Owing to the presence of water and to the continued settlement of the building the author hesitates to recommend a system of underpinning carried down to rock level, fearing that direct communication might be opened between the cylinder and the tunnel, thereby endangering the entire building As an alternative he proposed tying back the front wall with steel rods to prevent it from falling away from the remainder of the building After this operation had been carried out the lessees decided upon cylinder foundations, which were applied in a way constituting a new system of underpinning For details we must refer our readers to the paper itself It is satisfactory to note that since the work was completed there has been absolutely no settlement, although subsidence continued up to the time when underpinning operations were commenced

Notwithstanding its greater tensile strength, mild steel as at present manufactured is far shorter lived than old fashioned wrought iron In the atmosphere of large towns, at the seashore where the air carries particles of salt water in damp soil, and in places where stray electric currents prevail steel corrodes with undesirable rapidity Dr. Cushman attributes the inferiority of modern steel to various causes, chief among which are the presence and irregular distribution of manganese and other metals and the absence of slag. The foreign metallic elements are believed to favor electrolysis, and slag to act as a rust preventive. Within recent years the attempt has been made by an American rolling mill to produce steel with minimum percentages of carbon and manganese and without the impurities that are known to be responsible for corrosion. The product, which is technically ingot iron, appears to be of satisfactory character, if we may judge from a report by Prof McPherson, of Ohio State University Test samples of the new material and ordinary mild steel were immersed in a 5 per cent solution of sulphuric acid, with the result that the losses by corrosion were 0 21 per cent and 14 41 per cent, respectively. Other tests of specimens immersed in a 25 per cent sulphuric acid solution consisted of eyebolts, railway spikes, barbed fencing wire, corrugated roofing sheets, and ordinary nails Without stating the results in detail we can sufficiently indicate the superior qualities of the ingot iron by saying that the proportions lost by corrosion varied from one-fifth to one-thirty-second of the loss from the corresponding samples of steel. The subject is one which our readers should compel British steel makers to take into serious consideration.

TRADE NOTES AND FORMULÆ.

Cement Glue for Fastening Glass to Precious Metals.—Triturate to a fine paste 15 parts of sandarac gum and 5 parts each of marine glue, drying oil, white lead, Spanish chalk, and turpentine This cement, it is reported, becomes as hard as stone immediately.

Coating for Luminous Paper.—40 parts bichromate of potash, 450 parts of gelatine, 500 parts sulphide of potassium, perfectly dry, are ground and mixed. One part mixed with 2 parts of hot water Apply several coats, passing through the calendering machine after each coating

Varnish for Leather.—Dissolve 2 5 parts of ruby shellac and 0 75 parts of sandarac in 18 parts of alcohol (95 per cent) adding 1 part of turpentine oil, then filter the varnish and grind with 0.75 part of ivory black. The ivory black, being a rather heavy pigment, falls to the bottom if the varnish is kept for a long time; for this reason the bottles in which it is kept or transported should be well shaken before use

Stick Cement.- Melt 50 parts each of shellac and mastic and 10 parts of turpentine together in a water-bath. Allow the mass to cool a little in the vessel, and pour it out on to a sheet of parchment paper previously cooled and nailed firmly to a table. Then roll the cement out into thin sticks and, before the latter grow quite hard, bend them into a wave-like form by repeated twisting

Silver soap is made by dissolving soap in water till it forms a thick paste and adding to the mixture 2 parts of finest white tripoli, 3 parts of powdered chalk, and 1 part of jewelers' rouge Before pouring the soap into forms, a few drops of lavender oil should be added, which will impart a delightful fragrance to the soap and render it more easily saleable than unscented soap, since the "soapy" smell emitted by the latter on contact with water is not agreeable to every one.

India Ink.—I. Work up very finely sifted lamp-black with glycerine and a little size (mucilage) to the consistence of paste, then add a little white of egg and roll out the mass into sticks of about 3 inches in length, the sticks being pressed rather flat II. Work up fine pine soot with 0 25 part of size and 0 75 part of glycerine to the consistence of a pill and make it into sticks. If desired, a larger quantity of solvent may be added and the compound dispensed in bottles

Waterproof Paint for Metal.—A solution of 3 parts of Venice turpentine and 1 part mastic, is made in heated oil of turpentine and to this, 96 parts of linseed oil added and the whole heated on the water bath until the odor of oil of turpentine has completely disappeared With 115 parts of this varnish, rub down 20 parts of well burned freely ground clay, 80 parts of the best Portland cement, 10 parts zinc white and 5 parts of red lead After the whole has been well ground and thoroughly mixed together, add 25 parts of oil of turpentine.

Ink Pencils.—These are made of graphite and aniline colors, usually methyl violet, these substances being kneaded with water and clay to a plastic mass, which is then formed into small sticks and dried. These sticks when used on dry paper produce a pencil writing which differs from ordinary pencil marks in this respect, that it cannot be removed by a rubber. By means of moistened copying paper several clean copies can be taken No great pressure is necessary, only stroking with a paper-folder, and the letters will not become blurred

Cement Glue.—This is composed of 25 parts of Cologne glue, 16 parts of chemically pure white lead, 8 parts of fine zinc white, ½ part of camphor, 14 parts of water, and 1 part of alcohol. First sift the lead and zinc white into a suitable vessel and mix thoroughly, then boil the 25 parts of Cologne glue in 14 parts of water. Pour this glue solution on the white lead and zinc white, and stir till the mass has thoroughly combined Then add the camphor dissolved in alcohol, continuing the stirring Now allow the mass to stand, cut it on the following day into small pieces, and put the latter into a boiler provided with two pipes and heated by gas or alcohol, so that the cement melts and runs into the bottles. It is used for cementing porcelain, glass, etc.

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THE GREAT PARIS FLOOD

PARIS from the character of the Seine watershed is constantly exposed to inundation according to an engineering expert writing in the London Times but Paris is as heedless of the river as Naples is of Vesuvius or Messina was of earthquakes Observations have been taken at the Pont de la Tournelle for over two hundred and fifty years The normal depth of water there is from eight to ten feet when it reaches twenty feet it causes serious damage The greatest flood on record was in February 1658 when a height of twenty-nine feet was recorded The highest mark we have found for the recent overflow was 8 [illegible] meters a little less than twenty-eight feet The Seine's scale enables predictions of great accuracy to be made as to what will happen within twenty-four or forty-eight hours but it provides no means of avoiding what is impending An attempt to forestall the consequences of the floods has been made by building dikes along the river bank which are the quais with their retaining walls but the plans of the engineers were modified In some cases the walls were not made high enough in others as at the Place de la Concorde great gaps were left open to suit public convenience and æsthetic taste

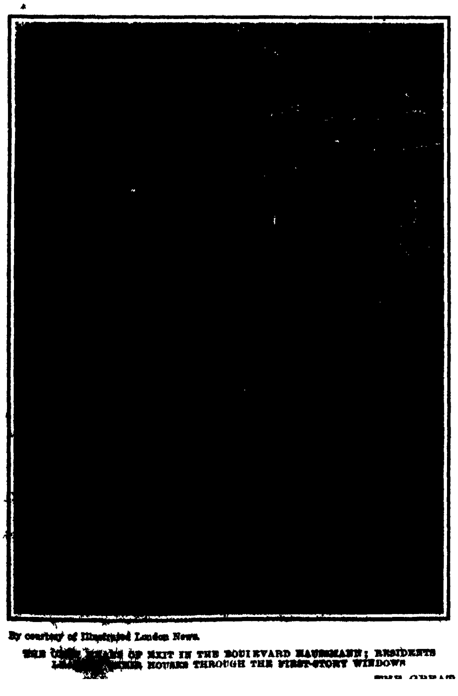
The floods are inevitable though until this year they had not been extremely high for a long time Some of the streams pouring into the Seine owing to the nature of their watersheds become torrents in heavy rains Others are slower in action but more dangerous for they accumulate water till it becomes excessive and then send it in a less rapid but greater body

(Continued on page 136.)

THE FLOODED ESPLANADE DES INVALIDES.

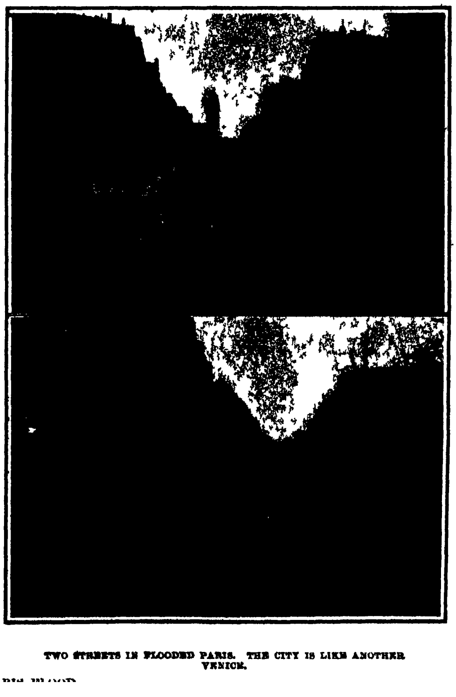
THE WATER INVADING THE AERODROME AT ISSY LES MOULINEAUX.

In fighting the progress of the flood the [illegible] have shown great energy All [illegible] barricades of bags [illegible] many cases [illegible] to the advance of the water proved ineffectual A special effort was made to prevent it from entering the [illegible] might be seen throwing up barricades of brick sand and [illegible]



By courtesy of Illustrated London News.

THE [illegible] OF EXIT IN THE BOULEVARD HAUSSMANN; RESIDENTS [illegible] HOUSES THROUGH THE FIRST-STORY WINDOWS



TWO STREETS IN FLOODED PARIS. THE CITY IS LIKE ANOTHER VENICE.

THE GREAT PARIS FLOOD

EFFICIENCY IN SHOP OPERATIONS.*

METHODS OF INCREASING IT AND SOME RESULTS SECURED BY THEIR ADOPTION.

BY H. F STIMPSON.

MANAGERS of industrial enterprises will undoubtedly agree that there are few qualities which are more to be desired in equipment methods and men than that of efficiency From an extensive study of this subject in various parts of the country together with interviews and correspondence with several hundred concerns the writer has become convinced that there is a general lack of definite comprehension of what efficiency is whence it springs how it may be measured and developed and the results which its cultivation will produce The object of this paper is an endeavor to throw some light upon these things and to offer a new viewpoint from which to study industrial operations

THE EVOLUTION OF INDUSTRIAL MANAGEMENT

In the first place we must realize that the management of industrial enterprises is in a state of evolution The tremendous growth of the past few years has caused certain previously satisfactory methods to become inadequate to present needs Many details which in the days of smaller affairs could be absorbed by personal inspection and mentally stored for use when needed must now because of their very volume be made matters of record

The character of these records has much to do with their value Because financial records are so ancient they have exerted an undue influence upon the character of all other records While under our present civilization the ultimate object of industrial operations is to create financial profits there are many highly important records which cannot be adequately expressed in terms of money The business of manufacturing consists of a repetition of mechanical operations Mechanical operations necessarily involve considerations of weight distance time and effort but not of money

The reason for the failure of so many cost systems to serve the desired end is that they are based upon a wrong unit These systems become useful only beyond a certain point Other systems have been the result of a blind craving for aid but being without broad underlying principles and not properly tied together and simply in many cases disjointed attempts to improve isolated details they too have failed The result is that attempts by specialists to improve industrial conditions have been often looked upon with suspicion and this is not altogether without reason These very failures however have drawn the attention of men in certain lines of engineering to the rapidly developing needs of manufacturers They have attempted to solve the problems by the use of engineering instead of by accounting methods and the results which have been attained prove conclusively that a material advance has been made

WHAT IS EFFICIENCY?

With this understanding of the present conditions let us consider what efficiency really is It has been defined as the ability to produce certain results and this at the very outset necessitates the existence or creation of a standard of measurement Our perception of efficiency therefore is correct only in proportion to the precision of the standard which must be accurately developed from data which are not only exact but complete A machinist believed to be operating at high efficiency was observed while turning a shaft His cut feed and speed seemed to be beyond criticism When the shaft was finished however he had to spend half as much time in hunting up a chain and pad to remove the shaft from the lathe as he had taken in turning it This cut his actual efficiency from 100 per cent down to 87 per cent yet the man was not at fault His normal work was to operate a lathe and not to hunt for things which should have been provided for him The points to be observed here are not only the importance of using the right standard of measurement but that the efficiency of the man depended very largely upon his surrounding conditions over which he had no control These conditions depend upon the efficiency of the management in securing proper equipment from the owners This in turn depends upon the efficiency of the management's records in enabling it to state clearly and accurately what increase in output and consequently in profits will result from improving the conditions—thus justifying the expenditure required We see from this that the true standard is not the possibility under existing conditions but that which can be obtained under other and more desirable conditions

MANAGERIAL OPPOSITION TO CHANGE

The management which immediately controls the records and conditions should be the prime source of efforts toward the increase of efficiency throughout the plant The opposition of managers to progress in this respect is exceedingly great yet not altogether surprising for these reasons

1 There is a wide-spread fallacy that so-called practical experience in the manual operations or technical processes of a business is the chief essential to success in its management This is due to the fact that perfection of workmanship of which he knows much, is more important in the eyes of the artisan than the actual cost of the operation of which he knows little or than the cause of this cost of which he knows less

2 It is only recently that educational institutions have afforded any opportunity for adequate instruction in the art of management pure and simple a principal feature of which is the intelligent regulation of cost

3 There has been and now is as a result of these two things a failure to appreciate the necessity and value of exact data in proper terms of refined and scientific methods of collecting and using them and of logical reasoning in the solution of industrial problems

The highest degree of efficiency therefore is only to be realized in a shop where executive methods have reached a high stage of efficiency for in these is unquestionably its source

TIME MEASUREMENTS IMPORTANT

The first step is to recognize the necessity and value of a proper measurement of time as a guide not only to the executive but to the workman A man was observed during eight successive repetitions of the operation of making a machine mold in a foundry The unit times varied from 5 2 to 23 6 minutes the total time for the eight being 104 minutes Under the method of timekeeping in use at that shop it was only ascertained that the eight operations took 1¾ hours or an average of 13 minutes each and the labor cost and distribution of burden were made on that basis Because of the absence of any standard time whatsoever it was not realized that had the man done each of the eight in 5 2 minutes they would have been completed in 41 6 minutes resulting in a saving of over 60 per cent of the total time Had the man received a proper work ticket bearing this standard time before he began the work there is no doubt that he could have easily performed the work in the shorter time and a marked difference in proportionate burden and cost would have resulted Under the existing methods the management could not know of the waste and so was helpless to prevent or cure it

Every item of time therefore is capable of division into two parts A standard or necessary time and a (more or less) preventable waste which latter is the easier thing of the two to determine

AN EXAMPLE OF INCREASED EFFICIENCY IN RIVETING

A gang of four were engaged in riveting some steel plates By the use of a stop watch it was found that a large proportion of the total time of the riveter and bucker up was not utilized yet some one was always at work The reason was that the men proceeded along the work in such a way that the bucker up covered with his body the holes as yet unfilled by rivets he moving from left to right When, therefore, a rivet was driven these two men had to stand aside until another rivet was placed by the rivet passer Upon the instruction of the engineer they reversed the direction of their movements so as to cover only the filled holes thus enabling the passer always to have a rivet ready for them and making their speed in driving the real gage of the speed of the operation Furthermore when they encountered a hole that needed reaming (as was sometimes the case until the fault was located with the fitters and remedied) the riveter would lay down the gun pick up the reamer, ream the hole lay down the reamer pick up the gun and drive the rivet When persuaded to test consecutively ten or more holes after driving the first rivet in a seam to anchor the plates and then to drive the ten consecutively they progressed faster with less effort These men receiving not only a standard from the engineer but kindly instruction as to how to attain it and being stimulated not by abuse but by a scientifically determined bonus increased their output over 150 per cent beyond the original amount

In this plant by the use of these methods and in about seven months the general increase in efficiency of the men was such that the force was reduced 67 per cent without reduction in volume of output but with a great reduction in net total unit cost even after paying the bonus alluded to and the cost of the expert services which alone produced this result

THE USE OF BONUSES

It is proper to say a word here on the subject of bonus as a means of increasing efficiency The principal merit of this motive lies in the fact that immediate personal gain is the strongest incentive to immediate personal effort It operates just as strongly on the employee as on the employer Hope of promotion is too vague and the actual chances too limited to exert much pressure but an extra sum in the pay envelope—or better still in a separate one for the disposal of the old man himself will do wonders To be most effectual a bonus must begin at the point of standard efficiency but at the point when average efficiency ceases and extra effort begins and it should increase on a curve faster and faster as the point of standard efficiency is neared because the accompanying effort will be correspondingly greater

EFFICIENCY METHODS AND DEPARTMENT HEADS

So much for the individual operator And now for the executives From foremen up to and including the highest official the same methods can and should be applied Under ordinary circumstances the workman in need of material tools or instruction keeps his skirts clear by a more or less indefinite and unintelligible request to the foreman He thinks it the foreman's duty to look after him but that if he does not do so it's no business of his Put that man on standard time and bonus and if there is anything he thinks the foreman should do or get for him he speaks loudly and directly This the foreman does not resent as would ordinarily be the case—for his efficiency is determined by the combined efficiency of his men and upon this his bonus depends Anything therefore that interferes with the progress of the men touches him closely and he will move heaven and earth to eliminate it All kinds of defects which were previously hidden from the superintendent are now brought to his attention and he welcomes them for exactly the same reason that actuated the foreman Thus the change that comes over a shop when efficiency is accurately measured and adequately rewarded is often astonishing

But this is not all The possession of exact data as to standard and actual times makes possible a certain great improvement in and addition to the executive staff and a material increase in the efficiency of the foremen and department heads By this is meant the installation of a planning department by which the apportionment of the time of men and machines is controlled * The advantage indeed the positive necessity of the service of engineers and draftsmen in apportioning the different parts of the product is well understood The requirements of each part the strains to which it will be subjected the kind quality and quantity of material required to resist these strains the shapes of the pieces their relations to each other and many other things are all given most careful attention The value of fully constructing the design on paper as a means of discovering possible errors or difficulties and of correcting or overcoming them before large expense for material and workmanship has been incurred are too well realised to need more than a simple statement for their acceptance No sane executive would expect his department heads to take a copy of his customer's order and individually work out the details with which they are particularly concerned and expect the parts to fit Yet this is just exactly what is being done as regards the apportionment of productive time, and a tumult of broken promises of delivery excessive costs of production enormous wastes of time in changing jobs, etc, is the immediate and unavoidable result.

WHAT CAN BE DONE?

It is perfectly possible, but only to one trained in the particular art, to schedule the different operations on all of the different parts of the product, to plot the productive times required, so that each may begin at such a time in relation to the others that all will arrive at the point of assembly at the proper time and in the proper sequence, to combine these studies of the different productive orders on a chart which will show the disposition to be made of all the men and machinery, to prepare advance programmes for each man and machine engaged in productive labor; and thus to give to the superintendent and foreman the dvantage of the same predisposition of time that they ow have of material.

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* The Iron Age

* See "Graphical Helps for Apportioning Time in Constructive Operations," Engineering Magazine, September [illegible]

As it is now, the time of these persons is entirely oo much occupied with this problem of the disposion of time for which they are only partly equipped, aving it is true much of the necessary information ut no training in the scientific handling of it They re therefore, unable to devote the time they should o the immediate study of the operations and the pro ision of tools material and instruction to the men They try to be all over the shop at once and they deend on getting their information at first hand and onsequently fail more or less clearly to cover the round Having such schedules and programmes as re above described and with the proper work tickets istributed on a dispatching board each one in the ivision representing the work upon which a man or nachine is engaged having the time of commencement nd the standard time thereon the foreman can see at glance without leaving his office what men will short y finish their work and what steps must be taken to ee that the drawings tools and materials for their ext work are ready for them in time Having seen o this he has some leisure to give his attention to natters immediately requiring it knowing if anything s obstructing the other men that their anxiety to earn heir bonus will cause them promptly to bring such natters to his attention Having this schedule more ver the foremen are enabled to order material etc head and to do so intelligently thus making the ork of the shop transportation department much simler In one case by this means 25 men were able to handle the intra shop transportation in a more satisfactory manner than 75 men had previously been able to do

The planning department also greatly aids and is in turn aided by the purchasing department for the times when material must or can be got can intelligently be determined to their mutual advantage The sales department too when it once gets the idea that the shop is not working miracles but has its limitations can make delivery promises which really mean something and can be kept and this is a trump card of no small importance when the fact becomes realized among the customers of the concern

RESPONSIBILITY OF THE MANAGEMENT

In the opinion of those whose opportunities have enabled them to get the facts the inefficiency in manufacturing which undoubtedly generally exists today in spite of the prevailing impression to the contrary is only about one fourth due to the things over which the employees have control and three fourths to conditions imposed upon them by the management The methods outlined above have achieved results whenever they have been faithfully and honestly tried with proper co operation by the management and under the direction of skilled specialists and the results have continued and will continue as long as the methods are followed The effect upon the men is that from being often listless indifferent and antagonistic they become energetic ambitious and loyal friends

One thing more Much has been done and over done in the line of so called welfare work It is a highly creditable and necessary line of effort when confined to attempts to remove from the path of the employee any obstacle which prevents him from developing his skill and efficiency to the highest degree An uncomfortable unhappy person cannot be efficient But as steam is necessary to the engine so is incentive necessary to the worker to get him to make the best use of the facilities provided for him Under our present civilization the same incentive which pushes on the master will push on the man and that is direct personal gain in dollars and cents not for himself but for and what that gain will bring It must come to him quickly after the exertion which its expectation calls forth for if long delayed the effect is lost It must also come to him separately from his regular wage that its amount may be the more readily realized

Moreover the results of efficiency methods within the writer's knowledge are sufficient to convince him that their general adoption would so increase the purchasing power of the employee by increasing his wages and decreasing the cost of production as to have a markedly beneficial and steadying effect upon the business of the country

Efficiency methods however cannot be successfully designed or installed by those trained in other lines and prejudiced by other associations After these methods have been scientifically developed to suit the existing conditions and actually put into operation by those skilled in the art they may gradually be relinquished into the control of those who have been educated in the process of installation with some hope of success for their future operation

THE PIONEER OF AERIAL FLIGHT.*

THE WORK OF SAMUEL PIERPONT LANGLEY.

BY ALEXANDER GRAHAM BELL.

Who are responsible for the great developments in aerodromics of the last few years? Not simply the men of the present but also the men of the past

To one man especially is honor due—our own Dr S P Langley late secretary of the Smithsonian Institution When we trace backward the course of history we come unfailingly to him as the great pioneer of aerial flight

We have honored his name by the establishment of the Langley medal, and it may not be out of place on this the first occasion for the presentation of the medal to say a few words concerning Langley's work

Langley devoted his attention to aerodromics at a time when the idea of a flying machine was a subject for ridicule and scorn It was as much as a man's reputation was worth to be known to be at work upon the subject He bravely faced the issue and gave to the world his celebrated memoir entitled Experiments in Aerodynamics

In this work he laid the foundation for a science and art of aerodromics and raised the whole subject of aerial flight to a scientific plane

The knowledge that this eminent man of science believed in the practicability of human flight gave a great stimulus to the activities of others and started the modern movement in favor of aviation that is such a marked feature of to-day

Everyone now recognizes the influence exerted by Langley on the development of this art The Wright brothers too have laid their tribute at his feet

The knowledge ' they say 'that the head of the most prominent scientific institution of America believed in the possibility of human flight was one of the influences that led us to undertake the preliminary investigations that preceded our active work He recommended to us the books which enabled us to form sane ideas at the outset It was a helping hand at a critical time, and we shall always be grateful

Langley's experiments in aerodynamics gave to physicists perhaps for the first time firm ground on which to stand as to the long-disputed questions of air resistances and reactions Chanute says

(a) They established a more reliable coefficient for rectangular pressures than that of Smeaton

(b) They proved that upon inclined planes the air pressures were really normal to the surface

(c) They disproved the Newtonian law that the normal pressure varied as the square of the angle of incidence on inclined planes

(d) They showed that the empirical formula of Duchemin, proposed in 1836 and ignored for fifty years, was approximately correct

(e) That the position of the center of pressure varied with the angle of inclination and that on planes its movements approximately followed the law formulated by Joessel

(f) That oblong planes presented with their longest dimension to the line of motion were more effective for support than when presented with their narrower side

(g) That planes might be superposed without loss of supporting power if spaced apart certain distances which varied with the speed and

(h) That thin planes consumed less power for support at high speeds than at low speeds

The paradoxical result obtained by Langley that it takes less power to support a plane at high speed than at low opens up enormous possibilities for the aerodrome of the future It results as Chanute has pointed out from the fact that the higher the speed the less need be the angle of inclination to sustain a given weight and the less therefore the horizontal component of the air pressure

It is true only however of the plane itself and not of the struts and framework that go to make up the rest of a flying machine In order therefore to take full advantage of Langley's law those portions of the machine that offer head resistance alone without contributing anything to the support of the machine in the air should be reduced to a minimum

After laying the foundations of a science of aerodromics Langley proceeded to reduce his theories to practice

Between 189 and 1895 he built four aerodrome models one driven by carbonic acid gas and three by steam engines

On the 6th of May 1896 his aerodrome No 5 was tried upon the Potomac River near Quantico I was myself a witness of this celebrated experiment and secured photographs of the machine in the air which have been widely published

This aerodrome carried a steam engine and had a spread of wing of from 12 to 14 feet It was shot into the air from the top of a house boat anchored in a quiet bay near Quantico

It made a beautiful flight of about 3 000 feet considerably over half a mile It was indeed a most inspiring spectacle to see a steam engine in the air flying with wings like a bird The equilibrium seemed to be perfect although no man was on board to control and guide the machine

I witnessed two flights of this aerodrome on the same day and came to the conclusion that the possibility of aerial flight by heavier than air machines had been fully demonstrated The world took the same view and the progress of practical aerodromics was immensely stimulated by the experiments

Langley afterward constructed a number of other aerodrome models which were flown with equal success, and he then felt that he had brought his researches to a conclusion and desired to leave to others the task of bringing the experiments to the man carrying stage

Later however encouraged by the appreciation of the War Department which recognized in the Langley aerodrome a possible new engine of war and stimulated by an appropriation of $ 0 000 he constructed a full sized aerodrome to carry a man

Two attempts were made with Mr Charles Manley on board as aviator to shoot the machine into the air from the top of a house boat but on each occasion the machine caught on the launching ways and was precipitated into the water The public not knowing the nature of the defect which prevented the aerodrome from taking the air received the impression that the machine itself was a failure and could not fly

This conclusion was not warranted by the facts and to me and to others who have examined the apparatus it seemed to be a perfectly good flying machine—excellently constructed and the fruit of years of labor It was simply never launched into the air and so has never had the opportunity of showing what it could do Who can say what a third trial might have demonstrated The general ridicule however with which the first two failures were received prevented any further appropriation of money to give it another trial

Langley never recovered from his disappointment He was humiliated by the ridicule with which his efforts had been received and had shortly afterward a stroke of paralysis Within a few months a second stroke came and deprived him of life

He had some consolation however at the end Upon his deathbed he received the resolutions of the newly formed Aero Club of America conveying the sympathy of the members and their high appreciation of his work

Langley's faith never wavered but he never saw a man carrying aerodrome in the air

His greatest achievements in practical aerodromics consisted in the successful construction of power driven models which actually flew With their construction he thought that he had finished his work and in 1901 in announcing the supposed conclusion of his labors he said

I have brought to a close the portion of the work which seemed to be specially mine—the demonstration of the practicability of mechanical flight—and for the next stage which is the commercial and practical development of the idea it is probable that the world may look to others

He was right and the others have appeared The aerodrome has reached the commercial and practical stage and chief among those who are developing this field are the brothers Wilbur and Orville Wright They are eminently deserving of the highest honor from us for their great achievements

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* Abstracted from an address delivered at the presentation of the angley Medal to the Wright Brothers, February 10th 1910.

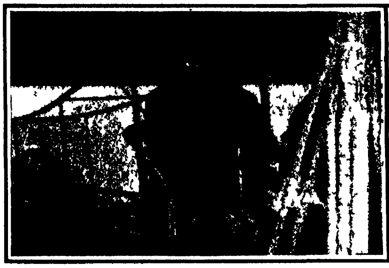
SOME EXPERIENCES OF AN AVIATOR.

HOW ONE MAN LEARNED TO FLY WITH A BLÉRIOT.

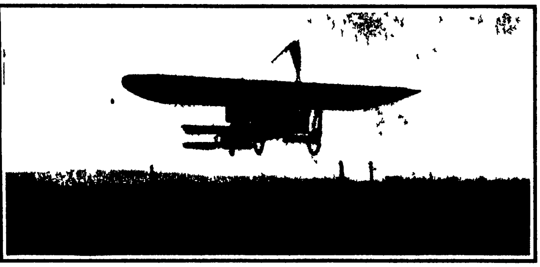
BY CLAUDE GRAHAME-WHITE.

In the beginning of 1908 my enthusiasm was aroused in aeroplanes and I immediately set to work to construct a model helicopter which at that time presented to me the best means of flying being a type of aeroplane that would rise from the ground immediately without any speed impetus in a forward direction I constructed a couple of models on this principle but soon discarded this form of aeroplane for I found that a tremendous power was required to lift the dead weight off the ground without attaining a forward velocity and although in theory the helicopter presented many advantages I found that in practice they were thoroughly outbalanced by the over numerous disadvantages

Toward the middle of the same year I on several occasions visited the works of Voisin Frères at Billancourt in the environs of Paris and derived considerable valuable information in connection with biplanes from M Gabriel Voisin I however always have had a penchant toward monoplanes which type of flying machine to my mind more closely approximates the natural flight of a bird



MR C GRAHAME WHITE AND FRIEND ON HIS BLÉRIOT No 12 TYPE MONOPLANE



A SUCCESSFUL FLIGHT WITH THE NEW TYPE OF BLÉRIOT MACHINE

I then set to work to ascertain which was the best type of monoplane at that time being manufactured and although I accumulated a good deal of knowledge it was not until M Blériot successfully crossed the Channel on his monoplane in July last that I seriously took up aeroplanes commercially Since that date I have devoted the whole of my time and attention to the subject and have visited all the various aeroplane meetings which have been held on the Continent and as a result of the experience I have thus gained my choice finally fell on a Blériot type monoplane several of which I placed orders for in August last I secured absolutely the first delivery of the big Type XII Blériot monoplane which differs very essentially from the Type XI in which M Blériot crossed the Channel

The last five weeks I have spent daily at M Blériot s works in Paris in order to thoroughly acquaint myself with the construction and various essential points in connection with the erecting of a successful machine My monoplane was due for delivery at the end of September but owing to M Blériot s special request I sanctioned its being exhibited at the first aeroplane exhibition at the Grand Palais in Paris where it was on view from September [illegible]th to October 17th which naturally very considerably retarded the date of delivery to me

At the closing of the exhibition the machine was removed to the E N V motor works which firm fitted the 60 80 horse power eight cylinder V type water cooled engine which has been the means of all the various very successful flights accomplished by Rougier in his Voisin biplane I did not decide on this engine until I had visited the works of practically all the other aerial motor manufacturers but after exhaustive research and trials I became convinced that my choice of an E N V engine was of the best

There are innumerable construction features in this engine which immediately recommend themselves to the novice inasmuch as while weight has been reduced to a minimum the essential and vital working parts have been kept well over the margin of strength to eliminate failure as far as possible from breakdowns These engines are water cooled and the copper water jackets are electrolytically deposited on the cast iron cylinders in the most ingenious manner thus obviating all packed joints and the consequent leaking and loss of water which may prove most disastrous when the machine is in actual flight

There is one central cam shaft which is fitted with seventeen cams sixteen of which operate the valves while the remaining one operates by means of a bell crank lever a plunger oil pump which forces the oil through the hollow crankshaft to the big end bearings and thence by suitable piping to the cam shaft pistons and gudgeon pins The lubricating oil is fed to the crank chamber by gravity and is kept at a constant level in the crank chamber by an ordinary float a downward movement of which opens a by pass to the oil tank which is automatically closed again by the float when the oil reaches its normal level

The magneto and pump are both placed on top of the engine and are driven by a short shaft and are very get at able and easily dismounted The crank shaft is fitted with ball bearings throughout and this system appears to be highly satisfactory The carburetor is placed in the center of the engine between the cylinders and by means of an ingenious arrangement of copper piping the vapor is collected in a center dome which insures equal distribution of the gases to the various cylinders and great economy in the weight of piping The cylinders are 100 millimeters bore by 130 millimeters stroke and 60 horse power the normal power of the engine is developed at 1 000 revolutions and at 1 500 to 1 600 revolutions 80 horse power The motor weighs—complete with accessories and coil and accumulator for dual ignition just over 300 pounds

As will be noticed from the accompanying illustration the design of the machine differs very essentially from the small Blériot type Calais Dover inasmuch as the engine is placed very much lower in the fusilage and the driver s and passenger s seats are placed behind the engine in the same plane thereby bringing the center of gravity very much lower insuring greater stability in flight

The propeller shaft is fixed high up in the extreme front of the machine and the propeller which has a diameter of 2 4 meters is chain driven and is geared down to revolve at half the speed of the engine for as precisely in the same manner for marine use the lower the revolutions of the propeller the greater its efficiency there being a greater grip of the air and less slip

After the *mise au point* of the motor and a six hours continuous run to test radiator efficiency and the satisfactory working of the pressure feed and all other details the machine was removed to Blériot s works to have the final adjustments of the wings the vertical plane and the fixed stabiliser rudder and elevator, and after several disappointments I eventually obtained delivery of my machine in working order at the Parade Grounds at Issy les Moulineaux at 7 30 on Sunday morning November 7th, and as I had gathered a good deal of useful knowledge and information from watching the antics and profiting by the errors made by other beginners on Blériot monoplanes I had a good idea of what not to do when the engine was started up and we were ready for our first trial As M Blériot was away in Vienna himself and none of his employees had ever actually flown a machine we had a more or less hazy idea as to how it should be controlled

It was a very cold morning but the engine started up at the first quarter turn After many warnings from M Blériot s foreman who was in charge that I was not on any account to accelerate my engine too much I mounted the machine along with my friend as passenger and immediately gave word to let go and we were soon speeding along over the ground at a good sixty kilometers an hour but with a sense of perfect control and safety and the faster we went the less inconvenience we found from the draft caused by the propeller Being very anxious to see whether the machine would lift off the ground I gave a slight jerk to the elevating plane and soon felt the machine lift off the ground but remembering the warnings of the foreman and being anxious not to risk breaking the machine I closed the throttle and contented myself by running around the ground in order to familiarize myself with the handling of the machine

As no flying is allowed after eight o clock on Sunday morning at Issy we only had half an hour s practice and highly satisfied with my first experience we started off to Mourmelon by car and after a 200 kilometer run we arrived there in time to see Mr Farman conduct some very interesting flights with a passenger which just at nightfall resulted most disastrously Owing to the breaking of one of the wires which operated his elevator he was unable to move it and the machine kept ascending against his will In order to avoid a more serious accident he had to shut off his motor and hundreds of spectators present were horrified to see the machine fall like a stone from a height of 60 feet

I happened to be on my car at the time the accident took place which was about a mile from Mr Farman s hangar from where I was watching his flights I immediately set out on the car with some of his mechanics and arrived first on the spot to find Mr Farman and his passenger absolutely unhurt but the machine smashed to pieces

I took a late train back from Mourmelon on Sunday night and arrived in Paris at 1 A M on Monday morning Then after three hours rest my friend and I turned out again and got down to Issy les Moulineaux about five o clock in the morning arriving some two hours before Blériot s mechanics turned up We however got the machine out and tied it to some railings and I then had my first experience of starting the engine which to a novice at first sight appears a most hazardous undertaking as unless the machine is either held firmly by several men or strongly tied up it immediately has a tendency to leap forward We however successfully managed to start the engine, and then rigged up a leash and when we had mounted the machine we let go, and before eight o'clock in the morning we had accomplished several very successful flights both with and against the wind These experiences we continued throughout the day, and by nightfall I felt quite capable of an extended flight if only the ground had been large enough

The following day we were out again early, and had absolutely no difficulty in flying the machine with my friend as passenger and sixty liters of gasoline and twenty liters of lubricating oil We, however had a somewhat unfortunate accident toward mid-day Another small Blériot had become damaged, and was stopped some two hours in the center of the field, which much handicapped my maneuvers, and at one time, when we were at a height of 25 feet, my whole attention appeared to be absorbed by this stationary machine in the middle of the practice ground In my over-anxiety to avoid going in its direction I accelerated my motor instead of decelerating as was my intention The machine then rose very much higher in the air than I had any intention to do and seeing that I should have to fly right over the stationary machine if I continued in my course I decided to make a hasty descent This I successfully accomplished in ample time before reaching the other machine and on grounding it was my intention to stop my motor I pulled the throttle toward me for this purpose being accustomed to decelerate motor cars in this manner but instead of closing the throttle by this action I opened it, and of course accelerated the speed of my engine so quickly that it caused the tail of the machine to turn right round in the same manner as a car would skid if the brakes were jammed on quickly on a greasy road The severe side strain of this movement caused one of the front forks of the front wheels of the machine which carry all the dead weight of the engine and passengers to twist and break and this put the machine *hors de combat* for the rest of the day

In order to give some idea of the weight of the machine I may mention that it took eight strong men to lift one side of it in order to wheel it back into the hanger The machine in working order with gasoline and lubricating oil for a three hours continuous flight weighs between 900 and 1,000 kilogrammes, or about a ton

The following day M Blériot had returned from Vienna and he sent for me and strongly urged us not to use the aeroplane any more at Issy, as he said the ground was far too small for such a powerful and fast machine and he further told me that he himself would not attempt to fly it there and strongly advised me to send it off immediately down to Pau where there is a very fine aerodrome with hangars and every other convenience for aeroplanists

I therefore immediately had the machine packed up and it is now on its way down to Pau and I propose joining the machine there with M Blériot early next week he having undertaken to personally instruct me and to make me thoroughly proficient in the management of the machine before bringing it over to this country—The Car

EXPLOSIVES FOR USE IN COAL MINES.*

HOW DYNAMITE IS THAWED SAFELY.

BY C. E. MUNROE AND CLARENCE HALL.

A LARGE number of different explosives can be formed by mixing various combustible substances with various oxidizing agents or by using such mixtures as dopes for dynamite or by using them together with the different nitrosubstitution compounds In fact the number is so great that a book published in 1895 gave the names of more than one thousand different explosives, and many have been added to the list since that date As the number of those in actual use is much smaller it is clear that most of the explosives known are for various reasons unsuitable for use indeed not one of those more generally known is suitable for use under all circumstances For instance some of them on explosion give off a considerable volume of flame some of them on explosion give off considerable volumes of poisonous or noxious gases some of them explode so quickly as to shatter the rock or other material in which they are fired and break it down into fine pieces some of them are too bulky and so on

It is evident that if we are seeking to break down the rock in an open quarry for the purpose of making use of that rock as ballast for roads we can employ an explosive that produces a long flame or gives off poisonous gases or shatters the material because the work is done in the open air and because the rock has to be broken up into small pieces anyway so that it is well for the explosive to do it If however we sought to get out from that quarry blocks of stone such as marble or granite which were to be used in building or for monuments we should avoid using the shattering explosive and choose one that slowly and without a shock separates the rock mass from the deposit Yet for this purpose also as the work is in the open air it might matter little if the explosive gave rise to a large flame or gave off poisonous gases provided the quantity of explosive used was small But the conditions in a coal mine are very different from those in a quarry The mine is inclosed and not out in the open air, and, moreover it is liable at any time to contain inflammable gases or coal dust or both which may form explosive mixtures with the air If under these circumstances an explosive were used which gave off a long flame on firing this flame darting out from the bore hole might set fire to the explosive mixture in the mine and produce a mine explosion

Moreover, as the mine is an inclosed space and as the wholesomeness of the air within it depends upon artificial ventilation it is also objectionable in such a mine to make use of an explosive giving off any considerable quantity of noxious gases which must be removed from the mine after the explosion before the miner can safely return to his work

Fig 2—BOXES OF DYNAMITE SHOWING METHOD OF PACKING IT

Considerations such as these have led to an investigation by the United States Geological Survey of the explosives offered in the market for the purpose of determining in the interest of the coal miner which of such explosives are suitable for use in coal mines and will do the work with the greatest degree of safety for the miner using them Of course it is impossible to insure complete safety for no explosive can be perfectly safe and every explosive should be treated with the greatest care and consideration

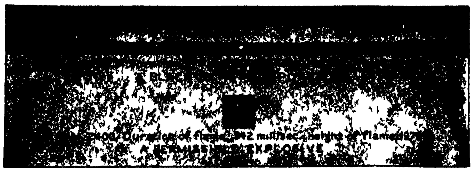


Fig 1—FLAMES FROM EXPLOSION OF EQUAL WEIGHTS OF BLACK BLASTING POWDER AND OF A PERMISSIBLE EXPLOSIVE

Fig 3—THAWER FOR FROZEN EXPLOSIVES

With this object in view the United States Geological Survey has established a testing station at Pittsburg Pa where there has been erected a large gallery made of steel, 100 feet long by 6 feet 4 inches in diameter and so made that it can be filled with fire damp or with coal dust and air mixed or with gas dust and air mixed in any desired proportion so as to reproduce the dangerous conditions that may occur in coal mines Attached to one end of the gallery is a very strong gun with a chamber representing the bore hole in a mine From this gun various exactly determined quantities of the explosive to be tetsed may be fired either untamped or tamped into the mixture in the gallery and thereby it can be learned whether or not the definitely known quantity of explosive used as described will cause the ignition and explosion of the mixture in the gallery Besides this gas and dust gallery there is at the testing station a collection of other apparatus and appliances by which to test the various properties of explosives and so to find their relative value and their relative safety for use in coal mines This investigation has been going on since September 1908 and there have already been published two lists of explosives that have passed all test requirements in a satisfactory manner and are considered to be suitable for use in coal mines provided they are used under the prescribed conditions

These approved explosives are therefore called by the United State Geological Survey permissible explosives

With reference to the characteristic component of each of these permissible explosives they may be placed in three classes—ammonium nitrate powders hydrated powders and nitroglycerin powders Most of these powders contain nitroglycerin and therefore they are all of the general nature of dynamite but the components and proportions of the dope have been so chosen and the mixtures so made as to modify very greatly the shattering effect upon explosion while at the same time the volumes of gases produced are relatively cool. As a result the flames produced are short and not lasting and coal is thrown out without being powdered when the proper charge of such an explosive is used and this charge is properly placed. These explosives are designed to take the place of black blasting powder which has been found to be unsuited for use in coal mines where dangerous gas or inflammable dust is present because of the great mass of flame which it produces and the long time that this flame lasts and because of the quantity of poisonous smoke and noxious gases which it gives out when exploded. Although explosives of the kind represented in the list of permissible explosives have been introduced into this country only during the last few years yet their consumption now amounts to several million pounds annually and is rapidly growing.

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* Abstracted from Bulletin 423, published by the United States Geological Survey.

Unfortunately though the permissible explosives are good coal getters and yield short flames that do not last and gases of low temperature so that there is little danger of igniting the explosive gases and dusts in mines when they are used still the gases they yield on explosion may be noxious and inflammable and miners are warned when using permissible explosives not to return to the breast after firing them any sooner than they would if they had fired a charge of black blasting powder.

Most of these permissible explosives will freeze. It is true that in making several of them materials have been added that prevent their freezing so readily but the manufacturers do not claim that such explosives will remain unfrozen when the temperature falls below 3[illegible] deg F. To keep any of the nitroglycerin explosives permanently thawed they should be stored where the temperature does not go below [illegible] deg F. On the other hand care should be taken that none of these explosives is subjected to high temperatures for this will render all of them more sensitive to explosion and is likely to cause the decomposition of some of them. It is best that the temperature of magazines in which they are stored should not rise above 90 deg F.

Explosives should not be exposed for any length of time to direct sunlight because this may lead to decomposition in those containing nitroglycerin nitrocellulose nitrostarch or substances of that kind. Explosives should be stored in a dry place for many of them contain considerable quantities of ammonium nitrate or of sodium nitrate and so will take up moisture from damp air and become damp. Too great dampness makes the explosive not any harder to fire but weaker when fired. Besides if the explosive is damp the nature of the gases produced will be different. Moreover as bodies like dynamite become moist the nitroglycerin contained in them tends to run out (that is what is called exudation takes place) and all the dangers follow that belong to liquid nitroglycerin.

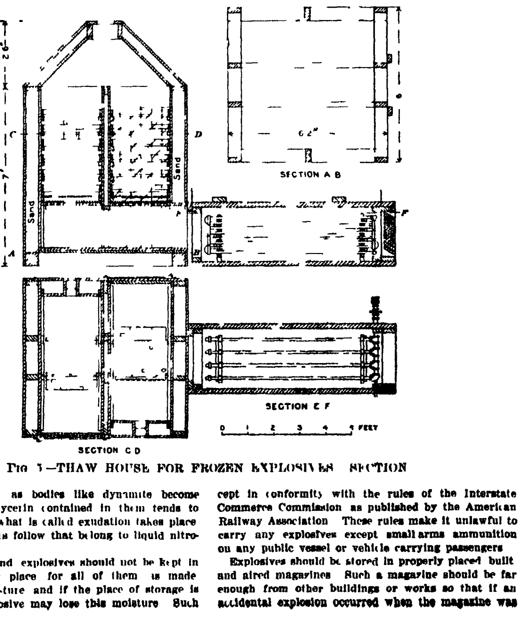


FIG 5—THAW HOUSE FOR FROZEN EXPLOSIVES SECTION

On the other hand explosives should not be kept in an extremely dry place for all of them as made contain some moisture and if the place of storage is very dry the explosive may lose this moisture. Such a change in composition will affect the explosive so as to change the speed with which the explosive reaction takes place within it and therefore the character of the work which it does when exploded. Naturally the longer an explosive is kept in storage the greater are the chances that change will take place in it and therefore the explosive should be obtained in as fresh a condition as possible and should be used as soon as possible after it is received. Also it should be kept stored in its original packages in the magazine outside the mine until wanted for immediate use and then used promptly.

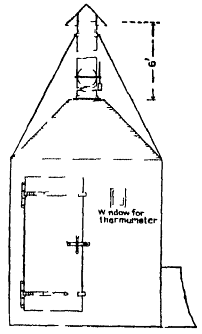


FIG 4 THAW HOUSE FOR FROZEN EXPLOSIVES ELEVATION

Dynamite is put up in sticks which are usually dipped in paraffin to make the wrapping waterproof. As by rough handling the folded edges may be broken open and the contents of the cartridge thereby exposed to the moisture of the air these cartridges should be handled with great care and they are best carried to the place where they are to be used in the cartons in which they are bought.

In handling explosives the greatest care must be taken to prevent their falling or getting shocks. They must not be thrown or dropped and portions of the powder falling from the cartridges must be carefully guarded against friction blows or fire.

Explosives should never be carried by railroad except in conformity with the rules of the Interstate Commerce Commission as published by the American Railway Association. These rules make it unlawful to carry any explosives except small arms ammunition on any public vessel or vehicle carrying passengers.

Explosives should be stored in properly placed built and aired magazines. Such a magazine should be far enough from other buildings or works so that if an accidental explosion occurred when the magazine was full it would do the least possible damage, and it should be placed as not to be in danger from forest, brush or other accidental fires. Magazines are best built of brick or concrete, but they are more frequently built of wood covered with corrugated iron. In any case they should be provided with wooden floors, which should be kept free from grit and dirt. It is best that only one kind of explosive should be kept in any one magazine. If more than one kind of explosive (other than permissible explosives) must be kept in the same magazine the magazine should be divided into rooms by partitions and the different explosives kept in different rooms. On no account should detonators or blasting caps or any device containing fulminating composition be kept in the same magazine with any other explosive. These firing devices should be kept in a dry place by themselves.

Plans and specifications for magazines will be furnished by manufacturers of permissible explosives.

The greatest care must be taken to prevent packages of explosives from falling or getting shocks. They must not be thrown dropped nor rolled. Wooden boxes containing explosives should be opened with extreme care so as to avoid friction and blows as much as possible. They should never be opened within the magazine but in a properly sheltered place outside of the magazine and at a distance from it. They should be opened only by the use of a wooden mallet and a hardwood wedge.

The thawing of frozen explosives requires extreme care and doing it improperly has frequently led to most serious accidents. No attempt should ever be made to thaw a frozen explosive by placing the cartridge before a fire or near a boiler or on steam pipes or putting it in hot water or by placing it in the sun. While thawing nitroglycerin explosives are extremely sensitive and should be handled with great care. During the thawing the nitroglycerin tends to separate from the dope and run out from the cartridge (that is to exude) and this is a source of danger.

When but a small amount of the explosive is required it may be thawed in the thawers that are furnished by all the manufacturers of explosives and have been found safe for use as directed. The thawer consists of a water jacketed tin vessel in which the cartridges are placed and which is closed with a tin cover. Before the water is placed in the vessel it is warmed up to a temperature not uncomfortable to the hand put into it and the cartridges are allowed to remain in the thawer until it is found by gently pressing them that they are completely thawed throughout. When thawed the material will feel plastic or like flour between the fingers. When frozen or partly frozen the stick will feel more or less rigid and hard. It is necessary that the stick should be thawed completely because dynamite when frozen can be detonated only with great difficulty and any part that is frozen will be but imperfectly detonated in the hole hence not only may such partly frozen powder fail to give its full effect as an explosive but there is danger of a serious accident in a coal mine where such powder is used because if a blown-out shot results the burning solid part may set fire to the dust or fire damp in the air of the mine.

Where large quantities of explosives are used daily a small thaw house should be provided for the purpose of thawing out the frozen explosive (See Figs 4 and 5). Plans and specifications together with a bill of material for such a thaw house will be furnished on application by the manufacturers of permissible explosives. The thaw house should be large enough to hold all the explosives used in one day's work. It should be heated by a small hot water heater placed at least 4 yards from the house the hot water being passed into the house through iron pipes at such a rate that the temperature in the house will not at any time be above 90 deg F.

Thaw houses are intended only for the treatment of explosives for immediate use and not for the storage of explosives for if powders or dynamites are left in this high temperature and dry air for a considerable time the moisture that is a proper part of them will be driven off and as stated before, this will markedly alter the character of the powder or dynamite and may lead to accidents in its use.

The difficulty encountered in the use of overhead conveyers running on rails is experienced especially when they have to be installed in existing workshops, in which it is difficult to find suitable points of support. Monorail tracks are not sufficiently flexible, are too heavy and require turntables or switches operated from the ground. The "Passe partout" system appears to avoid these inconveniences. The track consists of two parallel I beams, which are light and allow very small radii of curvature. Switching is facilitated by grouping several switching points together in a radial arrangement. The car is suspended from a rod which hangs between the beams, and oscillation is prevented by guide wheels. Shunting is effected by lightly pressing the suspending rod in the desired direction.

THE WRIGHT INJUNCTION.—II.

EXTRACTS FROM THE COURT'S OPINION AND THE BRIEFS.

Concluded from Supplement No 1781, Page 123

WHY CURTISS WING TIPS ARE AT DIFFERENT ANGLES

"In order to show the court the true angular relations of the adjustable tips of defendants machine to the wind we present a corrected sketch marked Complainants' Diagram of Operation of Defendants Machine' Fig 1 is the position shown by defendants sketch with one tip YC inclined downward 10 degrees from the normal position XL and the other tip YC inclined upward 10 degrees from the same line Fig 2 represents the machine with the motor throttled a little in which case the main aeroplanes must be inclined a little more in order to provide support for the machine at the lower speed The post B will then be inclined backward four degrees and the neutral position YL will be rotated in the same direction four degrees from the horizontal and the side rudders XC' and XC will likewise be rotated four degrees from the positions shown in Fig 1 In fact the entire machine will be rotated together four degrees from the original position The angle of incidence of XC' which was originally ten degrees will now be 10 minus 4 or six degrees while the angle of incidence of XC will be 10 plus 4 or fourteen degrees Although both rudders are adjusted to equal angles from the normal position XI there is a difference of eight degrees in their angles of incidence Under this condition the claim of Mr Curtiss that the angles of incidence must always be equal when the rudders are adjusted equal distances from the normal position YL is manifestly untrue

Fig 3 represents a case where the speed of the machine is still lower and the angle of incidence greater by eight degrees than in Fig 1 and four degrees greater than in Fig 2 This results in an angle of incidence on YC of 10 plus 8 or eighteen degrees, while the angle YC' is 10 minus 8 or two degrees Thus one tip will have nine times as great an angle of incidence as the other instead of having equal angles

WRIGHT MACHINE NOT LIKE PATENT

Wright Brief It is to be understood that in the aeronautical art aeroplanes may be flat or substantially so or decidedly curved and be mechanical equivalents of each other in every sense of the patent in suit'

Curtiss Brief 'In the only form of the device shown in the (Wright) patent in suit each aeroplane is absolutely flat and the only place where any other form is hinted at is in' (these) 'lines These surfaces may receive more or less curvature from the resistance of the air

It must be kept in mind that the machine of the patent is a gliding machine and that therefore any prior gliding machine is available as prior art In fact the patentees admit that the patent in suit is merely an improvement on prior machines for they state that 'Our invention relates to that class of flying machines in which the weight is sustained etc showing that this class of heavier than air gliding machines was a well known class of invention In one or two places in the specification it is specified that power might be applied to it for propulsion but no description of how the same could be applied is given and therefore it must be assumed that it would involve no invention to apply power to any glider Brief also alleges that certain lines in Wright patent (28 50 page 5) admit that machines of this character provided with a forward horizontal rudder and a rear rudder were old

It is alleged in the Curtiss brief that the only means described or hinted at for restoring equilibrium in the Wright patent is the warping of the main supporting surfaces themselves Attention is called to wording of specification, the record of application and what patentees then stated to their attorney

CURTISS DESCRIPTION OF HIS OWN MACHINE

The Curtiss machine is described by Mr Newell as follows "It has two main supporting surfaces both of which are curved and are absolutely rigid at all times and cannot be moved warped or distorted in any manner The front horizontal rudder is used for steering up or down, and the rear vertical rudder is used only for steering to the right or left in the same manner as a boat is steered by its rudder The machine is provided at the rear with a fixed horizontal surface, which is not present in the machine of the patent and which has a distinct advantage in the operation of defendants' machine as will be hereafter discussed

"Defendants' machine does not use the warping of the main supporting surfaces in restoring the lateral equilibrium, but has two comparatively small pivoted balancing surfaces or rudders. When one end of the machine is tipped up or down from the normal these planes may be thrown in opposite directions by the operator and so steer each end of the machine up or down to its normal level at which time tension u on them is released and they are moved back by the pressure of the wind to their normal inoperative position

When defendants balancing surfaces are moved they present equal angles of incidence to the normal rush of air and equal resistances at each side of the machine and there is therefore no tendency to turn around a vertical axis as is the case of the machine of the patent consequently no reason or necessity for turning the vertical rear rudder in defendants machine to counteract any such turning tendency At any rate whatever may be the theories in regard to this matter the fact is that the operator of defendants machine does not at any time turn his vertical rudder to counteract any turning tendency due to the side balancing surfaces but only uses it to steer the machine the same as a boat is steered

The complainants in their rebuttal affidavit have introduced an exhibit entitled Drawing Defendants Machine which shows an exaggerated and distorted machine apparently different from that set forth in their moving affidavit

CURTISS MACHINE NOT AN INFRINGEMENT

The position of the complainants is that although the defendants device does not answer the wording of the claims in suit it is an equivalent construction Even with such broad interpretation as the complainants contend for they substantially admit that each of the claims is limited to a construction in which the device must present different angles of incidence to the air and have a consequent turning tendency caused thereby and that the rear vertical rudder must necessarily be used to counteract such turning tendency Even with such a legal construction of the claims defendants do not infringe Defendants machine does not answer the claims as worded nor when construed according to the actions taken in the Patent Office and the interpretation of the claims put upon them thereby and this too without taking into consideration the prior art constructions

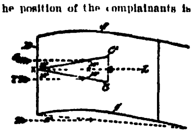


Fig 1.

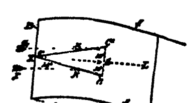


Fig 2.

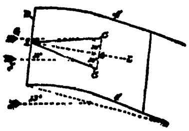


Fig 3.

Mr Newell goes on to say 'Complainants conclusions therefore rest solely upon their theories as to what ought to occur in defendants machine and their conclusions fall to the ground unless their theories are correct Their theories however have been riddled by Mr Curtiss's affidavit in rebuttal where he shows not only that the actual facts are that there is no appreciable difference of pressure on or resistance offered by defendants balancing surfaces, but that the vertical rudder is in fact not turned to counteract any turning tendency when the planes are warped The facts (are) directly denied by Mr Herring and Mr Curtiss (who are the ones who really know about the operation of defendants machine) but complainants theories even if true at any time are shown to be founded on false or erroneous assumptions and at most to be true only for an instant of time not sufficient in length to cause the results which they seem to think must necessarily flow from such theoretical causes Mr See's affidavit and that of the Wrights admit that the condition shown in Fig 3 of the 'Curtiss Sketch,' and in Fig 1 of 'Complainants' Diagram of Operation of Defendants Machine if true would not result in a difference of resistance or difference in angle of incidence and they have put in Figs 2 and 3 to try to show that the Fig 1 condition is not the normal This has been demolished in Mr Curtiss's affidavit in rebuttal where it is shown that the Fig 1 condition is the normal and the condition shown in Figs 2 and 3 only occurs instantaneously and not for a sufficient length of time to cause any turning of the machine Furthermore even the condition of Figs 2 and 3 does not occur when the wind changes strike the machine for at that time as specified by Mr Curtiss the balancing surfaces are in their normal position and therefore meet the change of the air current at equal angles and with equal resistances and before the balancing surface could be moved by the operator the normal condition shown in Fig 1 recurs with its consequent equality of angles of incidence and consequent equality of resistances instead of with an inequality of the same Mr Curtiss's affidavit also shows that the practical result in actual flight is the same whether the balancing surfaces are absolutely flat or are slightly curved

These results in defendants machine are of a distinct advantage and apparently could not take place in the machine of the patent in suit because as explained in the Newell affidavit the warping of the flat main supporting surfaces must of necessity result in a difference of angle of incidence and consequent difference of resistance on the two sides Consequently the operation of the rear vertical rudder to counteract a consequent turning tendency is unavoidable in the machine of the patent but is not a necessity and is not actually done in any of defendants machines

The function of presenting to the atmosphere different angles of incidence and different resistances as specified in the claims in suit obviously refers to a time when the balancing devices (whatever they may be) are actually operated for the purpose of restoring the equilibrium and not at some time when they are not so operated The record shows that when the equilibrium is restored in the patent in the suit the function specified in the claims must of necessity occur but they do not occur when defendants balancing surfaces are moved

In short even assuming that a legal construction of the claims as broad as the complainants contend for is allowable the question of infringement as substantially admitted by the complainants depends upon theories and facts which are asserted in the moving affidavits but equally strongly denied in the defendants affidavits and complainants position depends not only on the correctness of the theories advanced by them upon the application of those theories to the actual facts

That the word 'aeroplane of the claims means a flat surface as shown in the patent in suit as distinguished from a curved surface is furthermore corroborated not only by Lieut Selfridge but also by the Wright brothers themselves In the letter of Lieut Selfridge, on pages 16 and 17 of the Wrights moving affidavit he states

" Will you kindly tell me what results you obtained on the travel of the center of pressure both on aerocurves and aeroplanes?

In reply of the Wright brothers to that letter they state

' The travel of the center of pressure on aeroplanes is —— The center of pressure on a curved surface is approximately ——

These letters not only show that an uninterested party who was delving into this art considered that an aeroplane meant a flat surface as distinguished from a curved surface but the reply of the Wright brothers shows that this was what they considered themselves even as late as 1908 These facts corroborate the defendants contention that in the patent in suit the word aeroplane means a flat surface and not a curved surface and that the claims in suit are so limited '

There are over 400 miles of railway now in operation in Guatemala and various extensions are in prospect One of these contemplates the building of a line from Zacapa on the Northern Railroad about 100 miles from the sea to Santa Ana on the northwestern frontier of Salvador where it will connect with the British railway already built and thereby with the capital of Salvador Much of the coffee now grown in that republic will thus find an outlet to the Atlantic of which it has long been in need and it is highly probable that the bulk of the import trade to Salvador will also be conducted along this route.

THE GREAT PARIS FLOOD.

THE CAUSE OF THE GREAT INUNDATION.

Continued from Front Page

to swell the Seine. In the region around Paris the difference in elevation of the ground is slight. The river bed at the Tuileries is only a few feet higher than at Asnières after the Seine has taken a wide sweep around the whole city. The flooding of the sewers was due to the fact that the outlet of the main sewer at Clichy is flush with the river. It was placed there contrary to the plan of the engineer who devised the modern scheme of sewers. The blame for the inundation of the underground roads has not been definitely settled as yet. It is probably due to thoughtlessness and disregard of the Seine's possibilities on the part of all concerned.

The immediate remedies called for are clearly the building of higher and stronger embankments for the river and changes in the outlets of the sewer system that will prevent the floods from backing in. The condition, however, is a permanent one, and nature must be guarded against more effectively. In the eighteenth century it was proposed to fill in the ground of Paris to a height above all possible floods. That magnificent scheme is entirely out of the question today. Another plan suggested is to build a channel from the Seine above Paris to the first loop below the city and turn the flood water into this. That would cost 100,000,000 francs and would relieve only the city and its western suburbs.

The Times engineer seems to prefer the plan of damming up the streams of the upper affluents of the Seine, retaining the water in time of flood and letting it out when the rivers are low. He shows that the present freshet cannot be attributed to deforestation, for tree planting has been going on for years in the Seine watershed. He believes the floods to be due almost entirely to the nature of the soil, which cannot be changed. Meanwhile Paris, having enjoyed its fortnight of excitement, is on the lookout, as it ever is, for new sensations.—The New York Sun.

Discussing the question of the "Water Supply for the Lock Canal at Panama" in a paper read before a recent meeting of the American Society of Civil Engineers, Mr. Julio F. Sorzano sought to prove that during the three or four months' dry season on the Isthmus the various leakages and necessary uses of the canal and its structures would so reduce the water level of the lake at Gatun that it would be impossible to maintain in the canal the 40-foot depth which the present design prescribes. The various causes of loss of water were given as follows: Surface evaporation, border evaporation, percolation through the bottom and sides of the reservoir, lockage water, normal waste contingent to lockage, water for hydro-electric plants, structure leakage and waste, accident losses, and finally a general grouping of miscellaneous losses, such as the needs of the local population and industries, the uses of passing vessels, etc. A computation was given proving these leakages and uses would so reduce the water that the supply would be insufficient.

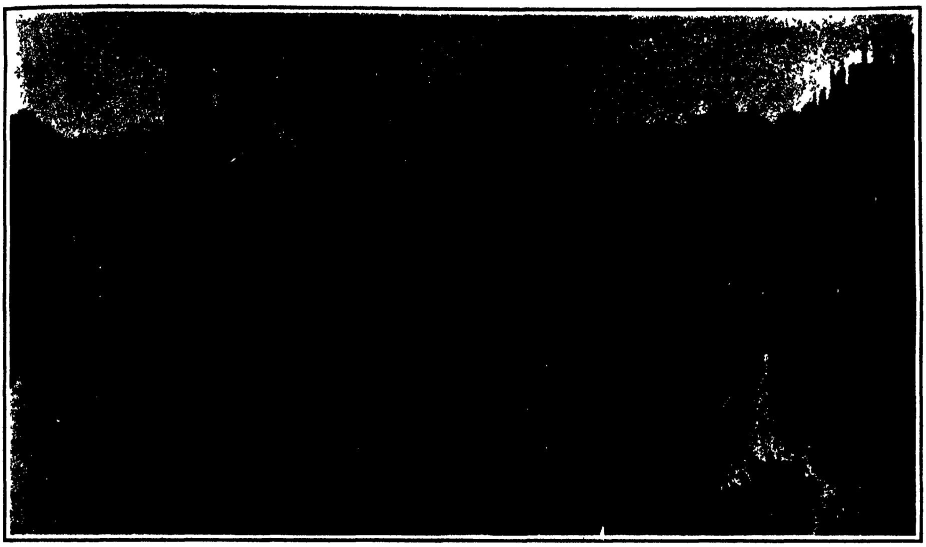
DEPUTIES' UNDIGNIFIED APPROACH TO THE CHAMBER

By courtesy of Illustrated London News.

1. The water almost [illegible] the Seine at its greatest height. 2. A submerged railway station: all that could be seen of the Gare des Invalides. 3. Trying to keep dry the cellars of a famous restaurant: water being pumped out of the restaurant Ledoyen. 4. At the Palais Bourbon during the flood: a temporary pathway.

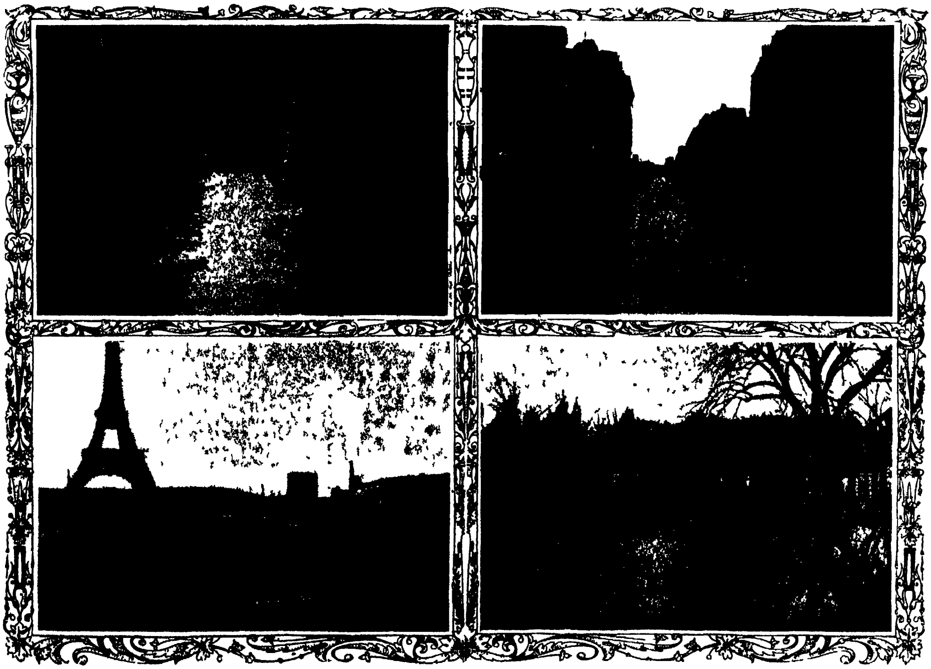
TYPICAL SCENES IN THE FLOODED SECTION

THE GREAT PARIS FLOOD



THE FLOOD AT ITS HIGHEST ON SATURDAY, JANUARY 29TH: THE ILE DE LA CITÉ AND THE SWOLLEN SEINE.

This drawing was made from a point on the Quai des Augustins opposite the Ile de la Cité, on which stands the Cathedral of Notre Dame. The Quai des Augustins is the "Booksellers' Row" of Paris, for there are situated the stalls of the second-hand booksellers, the favorite haunt of the book-lover in quest of finds in the shape of first editions. The boxes full of books that are shown clamped to the parapets of the quays are apparently safe, the parapet being high above water, but the booksellers have had to stop business long ago. The height of the water can be judged by the fact that the barges are moored at the extreme edge of the quay on lower wharf many feet below the parapet. This explains why they are some way out in the river. The first bridge seen in the picture is the Pont St. Michel. On the left further on is Notre Dame, and further still on the right bank is the Morgue. The top of a great crane jib in midstream may also be noticed. To the left of Notre Dame may be seen part of the Palais de Justice, and just to the right of Notre Dame in the distance the tower of the Gare de Lyon, and further to the right the chimneys of Bercy.



By courtesy of Illustrated London News.

5. A well known thoroughfare completely under water: the Rue de Lille. 6. The desolate appearance of a usually crowded street: the Avenue Ledru-Rollin [illegible]. 7. A scene of desolation: the Eiffel tower surrounded by the floods. 8. A swamp where the gayest crowd is usually to be found: the inundated Champs Elysées.

TYPICAL SCENES IN THE FLOODED SECTION.

THE GREAT PARIS FLOOD.

LEONARDO DA VINCI.—II.

THE ENGINEER AND MACHINIST.

BY EDWARD P BUFFET.

Concluded from Supplement No 1781, Page 128.

LEONARDO'S CREED—THEORY AND PRACTICE

Read a few more proverbs of science from Leonardo's notes and observe how intensely Baconian he is both as to the useful object and the experimental method yet how he preserves a balance between concrete and abstract processes

"Every instrument requires to be made by experience

"It is necessary to begin by experience and thanks to her to discover the reason of the phenomena

"Instrumental or mechanical science is of all the noblest and most useful seeing that by means of this all animated bodies that have motion perform all their actions and these movements are based on center of gravity which is placed in the middle dividing unequal weights and it has dearth and wealth of muscles and also lever and counter lever

"Experience never errs it is only your judgments that err by promising themselves effects such as are not caused by your experiments

"Experience does not err only your judgments err by expecting from her what is not in her power Men wrongly complain of experience with great abuse they accuse her of leading them astray but they set experience aside turning from her with complaints as to our ignorance causing us to be carried away by vain and foolish desires to promise ourselves in her name things that are not in her power saying that she is fallacious Men are unjust in complaining of innocent experience constantly accusing her of false evidence

"The man who blames the certainty of mathematics feeds on confusion and never can silence the contradictions of sophistical sciences which lead to a sophistical quackery

"There is no certainty in sciences where the mathematical sciences cannot be applied or which are not in relation to these mathematics

"Science is the captain and practice the soldiers

"Those who fall in love with practice without science are like a pilot who enters a ship without a rudder or a compass and who never can be certain whither he is going

"Be assured that it is necessary to study with system and patience the nature of the objects that one wishes to reproduce otherwise he loses his time and very uselessly prolongs the work

With what a shock to an age which still revered Bernard and Aquinas must have fallen da Vinci's Treatise on Painting containing such a doctrine as this

"No human investigation may be treated as pure science if it does not pass through mathematical demonstrations When you say that those sciences which begin and end in cogitation have also their truth I deny it on good ground I will not admit that in such reasonings experience is of no account since without experience there cannot be a bit of certainty

"It is said that mechanical knowledge" remarked Leonardo also "is that engendered by experience and the scientific that which is born in the spirit while the semimechanic is born in science and ends in a manual operation But it seems to me that those sciences are vain and full of error which are not born of experience mother of all certitude and which do not lead back to verification in experience that is to say whose origin means and end do not pass through any of the five senses

UNIVERSAL ERUDITION

Those who are best qualified to know Leonardo have insisted that the supreme condition of his liberty was solitude Though far from being an unsocial man there was in him a necessity for isolation of mind He valued his privileges with loneliness

While his genius was "universal" in the practical sense of a complete horizon it was such too in the philosophical sense of grasping universals or even in the mystical sense of entering into close communion with the universe Something akin to that state of mind so elusive of definition which mystics profess to experience seems to dominate a few sane observant and creative minds who are at the furthest possible removed from mysticism in the results they produce

The Medicean age when he lived was one of introspection a Swedenborg or a Pascal would have been more at home in it than a Goethe or a Newton Leonardo's output however is of a sort that indicates little self-consciousness but rather a broad interest in the things and people around him

May we not affirm that in his hours of brooding he was gazing not at himself, but through himself at the Macrocosm? That in this way he enjoyed a scope of vision and power of generalization which even his omnivorous curiosity could not have reached by its convivial exercise? That his nurtured intuitions were more prolific than mere study could have been? That in plain words the best understanding of men and things is not always gained in constant companionship with them?

Amiel a man of subjective bent very unlike da Vinci has described his own fits of abstraction in words which may furnish a clue to Leonardo's mind

"I am a spectator so to speak of the molecular whirlwind which you call individual life I am conscious of an incessant metamorphosis an irresistible movement of existence which is going on within me and this phenomenology of myself serves as a window opened upon the mystery of the world

The generalizing skill in portraiture which Leonardo shared with others of his artistic school has been verified by a mechanical test of recent times With composite photography the faces of several persons may be superposed and blended, if they belong to a special class the resultant emphasis of feature distinguishing them from groups otherwise composed may be taken as characteristic of the class This device has proven the accuracy of Renaissance painters in depicting typical physiognomy

But if it be true that genius reaches profound conclusions intuitively this does not mean that the mind really ignores details or reasons loosely but rather that the hard work is done in the subconsciousness Intellectual bricks cannot be made without straw and great results can come only from a great brain Astounding was the precision of Leonardo's mind and eye When dividing the human figure in his measurements he counted degrees points minutes minimes and semiminimes these forming a duodecimal series the smallest being a 248,832nd

UNITY

Stimulating to the modern engineer as may be the unlimited scope of Leonardo's genius a rarer inspiration is derived from its unity Other men have been versatile but they have kept their talents in separate compartments of the mind They have turned from one avocation to another for change and contrast The poet has cooled his brain cells by chair caning or poultry farming while the fashioner of brass and iron into useful shapes has flown from the monotony of his work to the strains of flute and violin Yet, for the ordinary man his several activities are in nowise related any more than for the savage are the sea currents which bear his boat with the moon which lights his way

For Leonardo all the laws of truth whether in science art or industry were consonant expressions of the same omniscient nature On those drudging members which other men esteem less honorable he bestowed more abundant honor and this he did not by segregation but by association There was no forced elevation of mechanics at the expense of the fine arts but a free social equality between them, with mutual help and dependence Power and utility were shown to be blood relatives of taste and humanity Our present day practician who cannot quite rid himself of a sense of squalor in his mental, as in his physical, surroundings should learn his dignity from old Leonardo

The reason that the example of this old Florentine is almost as fresh and needful to us as it was to the men of his own day consists herein That Leonardo not merely believed in unity but lived it

A theoretical acceptance of nature's oneness has become commonplace This was not so always Our Aryan progenitors supposed that the different manifestations of the physical universe were impowered by independent deities The sun, the sky the darkness the dawn the rain the lightning were actuated to regular or capricious changes by separate in-dwelling spirits As the human mind has progressed it has tended to fuse these divisions of control into a single power One of the most fascinating studies in the history of thought is to follow the paths along which from exceedingly remote times pluralism, as a conception of nature has been yielding to monism

To our minds it has become a truism that all things which move are inflexibly geared together For Leonardo before the time of Paracelsus, to perceive the same was an honorable feat but had he done no more than that he would scarcely be required for our emulation What distinguishes him as a model unique for all time is his realization of his scientific faith; he was its vital exponent

Science was to him the schoolmaster of industry, and mechanics the preceptor of art Painting was applied anatomy and anatomy was explained by the laws of the lever As an ornithologist he wrote a treatise on the flight of birds, which was a kinematical study, and on this he based the principles of the airship If the flying machine ever be perfected it will follow, as he foresaw, the pattern of winged animals just as the fleet vessel must approximate in contour to the fish and every optical instrument must simulate the eye

Optics was one of the sciences that Leonardo studied profoundly and applied in his pictures Perspective he well understood, his notebooks reveal how he scrutinized the human countenance from judiciously chosen viewpoints Binocular vision he found intelligible and employed to advantage His figures are artfully caused to stand out in space by sharp delineation of the important features toward which the observer's eyes will instinctively converge while a soft obscurity envelops those lines which naturally will be seen out of focus

For Leonardo neither esthetic nor industrial products were at an end exclusively but he co-ordinated them as objects of intrinsic worth and called upon the methods of both to lend reciprocal assistance To the gears and levers of his mechanical sketch books he deemed it not ignoble to devote those pencil strokes which might have outlined a Madonna or an Adonis Botanical studies aided him in adroit imitation of foliage The crests of breaking waters whose powers he measured were molded by his fancy into grotesque shapes which his pencil congealed

"Especially where there is relation and proportion" wrote Leonardo "is there a place for calculation and the proportion is found not only in numbers and measure but also in sounds weights times, and places, and in every force whatsoever it be

"Mathematics" said he "are necessary to the painter for the painting forms a part of them

"Painting is a new creation of nature it embraces all the forms of the visible Perspective is the brake the rudder, of the painter

"The science of mechanics is as universal as that of painting for every action is produced by motion and motion is the cause of all life

"There is no sound without motion" he remarks "and no motion without force The force is caused by the motion in the weight The blow is born of the weight and the motion"

A certain breadth of functions was common among da Vinci's contemporaries Michael Angelo and Raphael were architects as well as artists Responsibility for the effect of a painting did not end with putting on the pigments I translate from Paul Errera in the Revue de l'Université de Bruxelles

"With the picture the artist composes the frame with the fresco the entire decoration of the chapel or hall, marble wood stucco wrought iron all come out of the same shop The saying is found in Vasari *a propos* of Verrocchio Herein is the supreme harmony of the beautiful works of the Renaissance—they are conceived for a determined position, they fit their surroundings and their proportions are calculated as are those of the architecture, to which they are connected moreover, with a thousand perceptible bonds'"

INCIDENTS OF DA VINCI'S LIFE

Leonardo's birthplace, which gave his surname was the village of Vinci, in Florentine territory His father, Piero, son of Guido, was a lawyer in a line of lawyers Soon after Leonardo's birth, which occurred in 1452, his peasant mother, Caterina married a man of her own rank in life, but Pietro brought up the boy in his house with the advantages that his fast growing means afforded

In the studio of Andrea del Verrocchio, at Florence, da Vinci spent his youth, learning to draw and paint, to model and chisel, to found and weave With the brush he soon became so surpassingly proficient as to inspire a legend that he drove his master to abandon the profession in chagrin

Anatomy of the body taught him what to draw, while anatomy of the eye led him into subtle confidences with the observer whom he wished to impress A pre-Raphaelite in very truth he ignored tradition and learned from nature wisdom in portrayal When his fancy passed from the beautiful to the grotesque, his scientific spirit led him to produce a heraldic dragon synthetically from reptiles and insects,

While developing his powers, Leonardo did not neglect the amenities of life. Vivacity and magnetism of temperament, generosity of disposition, were joined to a physique of combined strength and beauty which dazzled his contemporaries. It is handed down that he could twist horseshoes in his fingers and ride unbroken horses. Such a glow he left in the world after four centuries Robert Louis Stevenson could write "Of the misbegotten changelings who call themselves men, and prate intolerably over dinner tables, I never saw one who seemed worthy to inspire love—no, nor read of any, except Leonardo da Vinci, and perhaps Goethe in his youth." No picture of Leonardo in his young manhood remains, and how he then looked we can but dimly infer from the hirsute portraits of his mature years.

The age of Lorenzo de Medici was dawning upon Florence, and after Leonardo's debut as an artist *sui juris* he is found working under patronage of that magnificent prince. About 1480 lies an obscure period in his annals, and it is supposed by some that during this epoch he made certain mysterious travels in the East—to Egypt, Constantinople, Asia Minor, Armenia It is believed that he served as engineer for the sultan of "Babylon," to wit, Cairo. His mind had early turned to mechanical pursuits and the financial unsuccess of his paintings disposed him to military architecture as more lucrative We can only conjecture how much added wisdom he brought back from the Orient to Italy

The prime of his career began about 1484, with the service of Duke Ludovico Sforza il Moro, at Milan, to whom he was recommended by Lorenzo It is told that he was called to Ludovico's court as a violinist, and that he bore a curious silver lyre of his own invention. Those who thus relate do not overestimate his proficiency in the creation and theory of sound, and the incident may be founded on fact, but the main grounds for his employment by Ludovico were his ability as a military engineer and his skill as a sculptor Among ten qualifications confidently named by him to the duke, military engineering is prominent although civil engineering, painting and sculpture are not omitted At this time he bid for work which subsequently, in a procrastinating manner, he carried out the huge bronze equestrian statue of Ludovico's father, Francesco Sforza. The fortunes of war soon gave this ponderous image to destruction.

At Milan, da Vinci's activities and studies were multifold Intermittently he built war engines, planned court pageants, researched in optics, geometry, and anatomy, and engaged in vocations too varied to describe He improved the Martesana canals, thereby enriching the city, and he benefited the agriculture of Licino by irrigation In this period he painted the "Last Supper," which shares pictorial supremacy of the world with Raphael's "Sistine Madonna" and Michael Angelo's "Last Judgment" Before the end of the ten years during which he labored by fitful intervals on this mural masterpiece, the monks whose dining room it was to adorn grew tired enough of waiting for its completion, since Leonardo's art was long in realization of his conceptual types, lax in application, and infinitely painstaking in detail The remark has been made of him that he finished nothing, or if he finished, it was only to commence anew Unhappily, this painting furnishes an instance where his alliance of art and science was fickle, for, anxious to obtain the unusual effect of oils in fresco, or to employ a method that allowed more deliberation and revision than the ordinary mural processes, he taxed his chemical skill and victimized the priceless picture in an unsuccessful experiment After repeated peelings and restorations, it is doubtful that any of the work now visible is his.

In this long term of residence under Ludovico's protection, Leonardo became principal of an academy which grew famous and which has been called the first scientific and experimental academy in Italy He accumulated no fortune at Milan, for he was not a sharper, and throughout most of his life a bad money maker, his powers of mind and hand being appreciated by his patrons in any way except pecuniarily

This luxurious if not lucrative period of Leonardo's life was brought to an end by the army of Louis XII. of France, which entering Lombardy in 1499, soon reduced Milan and made Ludovico a prisoner Leonardo took refuge in Venice and Florence, at which latter place he engaged in painting and other professional work He projected at this time the canalization of the Arno and proposed to move the St. John baptistry to a new site by means of water power from the river, neither of which plans he was permitted to execute.

Some two years after the fall of Milan he placed his services at the disposal of Cesare Borgia, who was under French patronage and a bitter enemy of Ludovico. For this famous assassin da Vinci built military machines, strengthened fortifications and traveled, minutely mapping wide regions of Tuscany. He was thus commissioned private architect and general engineer of the duchy of Urbino.

His facile changes of his political clothes will be condemned especially by those who esteem "patriotism" above all virtues. The circumstances, however, were peculiar Artists and savants were a privileged class of supernumeraries; then, too, the partisan life in Italy was mixed and shifty But best he may be vindicated through drawing due distinction between dynastic pretensions and public interests In the downfall of a state its proletariat have usually cause for rejoicing.

Less consistent with an immaculate character, was Leonardo's readiness to hire himself out to make gun carriages, catapults and battering rams To be sure he followed the almost universal judgment of mankind that in preparing for war business is business But Leonardo must be held to stricter account than ordinary men. His clear mind should have been revolted by the incongruity of his fighting machines with the sacred themes of those paintings to which he devoted himself His imagination could indeed be touched with the "bestial frenzy" of war as a motive for a great picture In his private dealings he was forbearant, victimized rather than victimizing It is odd that he assumed the canons of morality binding on individuals to be annuled at the caprice of a prince or will of a nation Like his earlier compatroit, the Saint of Assisi, he might be never so stern with himself, yet deferred obediently to external powers

Relieved by Borgia's downfall, in 1503 from his active labors, Leonardo settled for three years at Florence, which city he might instead have been called to lay in ruins had not the duke's quietus frustrated the plan for an attack He there, in cartoon competition booked an order to print a battle scene for the Hall of Council This cartoon it was, which depicted the combat of the Anghiari the "bestial frenzy," as he called it, of war, and it may be that the choice of the subject was tinged with remorse Again, however, science betrayed art and failure of a process by which he had hoped to bake the picture into the wall occasioned his abandonment of the contract Instability was one of his besetting faults But at Florence he painted the Mona Lisa del Gioconda, for which subsequently Francis I of France paid 45,000 francs and in which biographers have sought to find the one romance of Leonardo's solitary life He there conducted rigorously scientific studies of the flight of birds their feathery and muscular structure and the resistance of the air, applying the results of these researches to designs of machines for artificial flight

To Milan he came once more in 1506, and dwelt for several years in peace and preferment under Charles of Amboise who was appointed governor by the French king Louis XII That monarch a visitor at Milan, became an admiring patron of Leonardo, who was endowed with the dignity of his painter and engineer Da Vinci became an honored guest and habitual dweller at the villa of Francesco Melzi, a young disciple who afterward followed him like a dog In this term of residence at Milan he engaged in hydraulic work, including the Martesana canals again, and the basin of San Christoforo Two other pursuits were expeditions to the mountains in the north of Lombardy to study their formation and researches in the dissecting laboratory which perfected his skill as an anatomist

At the close of 1511 Milan was shaken by another revolution, the French party being driven out and Maximilian Sforza son of Ludovico coming in Two years later Leonardo turned his face toward Rome, where Giovanni da Medici, son of Lorenzo, was Pope The successor of St Peter was pleased at first with da Vinci's curious scientific experiments more so than with those which later he undertook in concocting a new unctuous medium for a picture that he had been commissioned to paint But suspicions of necromancy or heresy were aroused against him and even heeded by the Pope His anatomical dissections were deemed especially an offense. On the whole, he received little encouragement at Rome, therefore he turned from his brushes to birds and airships and ere long quitted the city It has been suggested that he was injured through Michael Angelo's jealousy This young contemporary shared a little of Leonardo's versatility and worked as architect on St Peter's church The same is true of Raphael, whose artistic production was done by hatching the eggs that Leonardo had laid. With all due respect for the junior members of this triad, it seems to be a descending scale.

Rome's atmosphere of chill for Leonardo could have caused him few shivers, he was fortunate that it caused him no burns He cared little for the canons of the hierarchy and his note books bristle with caustic epigrams on the monks of that vicious age. While he lived and died a nominal Catholic, and got along better than Galileo, his spirit was that of the critical Erasmus though hardly that of the austere Savonarola Leonardo was indeed an inveterate free thinker, though not in the sense of being an irreligious man, as is evidenced both by his sympathetic treatment of sacred themes for painting and by his inscriptions, as a man of science, to the prime mover of the world, creator of power and order.

Yet once more Milan was entered by the French, whose king, Francis I then come to the throne, added to the favor of his predecessor toward Leonardo an adoring enthusiasm By his invitation the artist left Italy for France at the close of 1515 followed by Francesco Melzi, and took up a residence at Chateaux Cloix, in Touraine.

There he lived, doing a little painting and canal work, until he dropped away This occurred in 1519, his sixty-seventh year, when age had palsied his hand but had not sapped his intellect

"I do not believe," said the king, "that there is in the world another man as wise as Leonardo, not only as sculptor painter and architect but as a profound philosopher" This verdict may stand until the next superman appears

It has been alleged that Leonardo wasted his talents by diffusion of effort and that his actual accomplishments were comparatively slight Therein is a half truth His paintings were few compared with Raphael's, and most of his inventions were stillborn Had he specialized as men specialize today, he would have achieved something so spectacular as to be the world's transcendent marvel But for conviction that his definite results were tremendous, it is needful only to examine the records which he left behind Rarely were his discoveries followed up, yet that does not belie that he made them

LEONARDO'S REMAINS

Of Leonardo's literary output, the work that has longest been published, though not in his lifetime, is his "Treatise on Painting" He projected various others, such as a "Book of Motion," "Treatise on Impact" "Machine Elements," "Book of Gravity," and "Book of Momentum" These, if completed are said to be lost, but no doubt many of the ideas contained in them have been preserved elsewhere in his teeming and bewilderingly arranged manuscripts

Data of his long productive years were kept by him in the form of notes and drawings covering thousands of sheets A single page would contain say a bar bending machine ensemble details of ratchets and worm gears, the design of an architectural cupola, the study for a grotesque head or a philosophical sentiment any of these subjects dovetailing into the odd corners left by others on the paper, as they did in his mind It was his purpose to classify his manuscripts, but his death left them unassorted

By testament they passed with his other chattels to his famulus, Francesco Melzi, who brought them back to Italy and cherished them for 50 years After Melzi's death some of them fell into the hands of one Mazzenta, who, being convinced that he had no right to them, restored them to Dr Orazio Melzi a gift which the latter requited by bestowal on him of many manuscripts But Pompei Leoni sculptor and brass founder to Philip II of Spain, was then living in Milan where he had accumulated an art collection He induced Melzi to bid from Mazzenta the volumes before rejected, in this way Leoni obtained seven of them and otherwise got hold of three more These manuscript books were taken apart for him and rebound in a great volume 18 x 27 inches, with an arrangement, or lack of arrangement attributable to the convenience of the binder More than 1,700 groups of drawings were comprised in 402 folios windows being left in the leaves for matter on the back sides of the sheets By reason of its magnitude or atlas-like character this collection became known as the "Codice Atlantico"

This Codex was carried by its owner to Madrid but brought back to Milan and lay in the Ambrosian library until 1796 In that year it, with twelve or fourteen other volumes of Leonardo's manuscripts was stolen by Bonaparte and sent to Paris as loot After Waterloo it was returned to its Italian home, where now it rests The minor manuscripts however, had been deposited in the Institute, at Paris, instead of the National Library with the Codice Atlantico and by an oversight they were not restored to Italy then nor have they been since Within the last 20 years they have been published under the editorship of Ravaisson Mollien, in facsimile, accompanied by the deciphered text in both Italian and French, thus filling six huge folio volumes

Still more lately the Accademia dei Lincei at Rome with governmental aid, has completed a limited edition of the Codice Atlantico in facsimile plates mounted on large sheets like drawing paper The process of reproduction is superior to that used for the French collection, but there is no transliterated text This is more of a drawback for the casual researcher than might be supposed and unless he has learned the trick of Leonardo's chirography, he will find it as incomprehensible as Arabic The characters are small, detached letters, fairly clear, but at first stubbornly defying interpretation The difficulty is lessened, if not entirely removed, by information that Leonardo, who was left-handed, habitually wrote backward, so that the manuscript must be read as in a looking-glass.

Other collections of da Vinci's sketches and writings

e preserved in European libraries, including those of lorence and Venice, of Windsor and the British Mu- um After long obscurity, much of them has been iblished Among them is a little notebook on the ight of Birds

But no other equals in importance or interest the odice Atlantico This work may now be seen at the w York Public Library and probably at other large ies in the United States. Rarely does anybody ask look at it; but either artist or engineer who fails to spend at least a day in its perusal is contemning the most majestic documentary monument of his profession.

Huge facsimile editions like those that have been described are manifestly, however, unavailable for general use, and a digested classification of the matter contained is imperative for any but the most leisurely reader No illustrated popularization of the scientific material in either the Institute collection or the Codice Atlantico has, to my knowledge, hitherto been brought out in the English language. This has been done in France by M. A. Ronna, who, in the Bulletin de la Société d'Encouragement pour l'Industrie Nationale has described da Vinci's hydraulic machinery from the Atlantico, with a long sketch of his life; and in Germany by Prof. Beck, who has treated his mechanical output quite exhaustively The former has been helpful in preparing the present article; to the latter, special credit may be reserved for a future paper in which we shall examine some of Leonardo's work.—American Machinist.

PROGRESS IN WIRELESS TELEGRAPHY.—I.*

A NOBEL PRIZE LECTURE.

BY GUGLIELMO MARCONI.

The discoveries connected with the propagation of ectric waves over long distances, and the practical pplications of telegraphy through space, which have ained for me the supreme honor of sharing the obel prize for Physics, have been to a great extent e result of one another

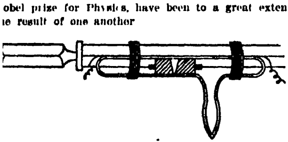


FIG 1.

The application of electric waves to the purposes of ireless telegraphic communication between distant arts of the earth, and the experiments which I have een fortunate enough to be able to carry out on a rger scale than is attainable in ordinary laboraries, have made it possible to investigate phenomena nd note results often novel and unexpected In my pinion many facts connected with the transmission electric waves over great distances still await a tisfactory explanation, and I hope to be able in this ecture to refer to some observations which appear to quire the attention of physicists

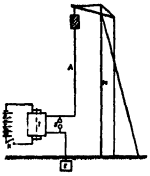


FIG 2.

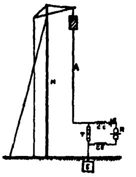


FIG 3.

In sketching the history of my association with diotelegraphy, I might mention that I never studied hysics or electrotechnics in the regular manner, lthough as a boy I was deeply interested in these ubjects I did, however, attend one course of lectures n Physics under the late Prof Rosa, at Livorno, and was I think I might say, fairly well acquainted with e publications of that time dealing with scientific ubjects, including the works of Hertz, Branly and ighi At my home near Bologna, in Italy, I com menced early in 1895 to carry out tests and experiments with the object of determining whether it would e possible by means of Hertzian waves to transmit a distance telegraphic signs and symbols without he aid of connecting wires After a few preliminary xperiments with Hertzian waves I became very soon convinced that if these waves or similar waves could be reliably transmitted and received over considerable distances a new system of communication would become available possessing enormous advantages over flashlights and optical methods, which are so much dependent for their success on the clearness of the atmosphere My first tests were carried out with an ordinary Hertz oscillator and a Branly coherer as detector, but I soon found out that the Branly coherer was far too erratic and unreliable for practical work.

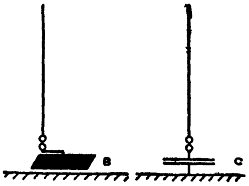


FIG 4

After some experiments I found that a coherer, constructed as shown in Fig 1, and consisting of nickel and silver fillings placed in a small gap between two silver plugs in a tube, was remarkably sensitive and reliable This improvement, together with the inclusion of the coherer in a circuit tuned to the wavelength of the transmitted radiation, allowed me gradually to extend up to about a mile the distance at which I could affect the receiver

Another, now well known, arrangement which I adopted was to place the coherer in a circuit containing a voltaic cell and a sensitive telegraph relay actuating another circuit, which worked a tapper or trembler and a recording instrument. By means of a Morse telegraphic key placed in one of the circuits of the oscillator or transmitter, it was possible to emit long or short successions of electric waves, which would affect the receiver at a distance and accurately reproduce the telegraphic signs transmitted through space by the oscillator With such apparatus I was able to telegraph up to a distance of about half a mile Some further improvements were obtained by using reflectors with both the transmitters and receivers the transmitter being in this case a Righi oscillator This arrangement made it possible to send signals in one definite direction, but was inoperative if hills or any large obstacle happened to intervene between the transmitter and receiver.

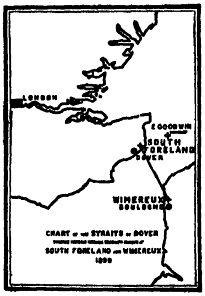


FIG 5.

In August, 1895, I discovered a new arrangement which not only greatly increased the distance over which I could communicate, but also seemed to make the transmission independent from the effects of intervening obstacles. This arrangement consisted in connecting one terminal of the Hertzian oscillator, or spark producer, to earth, and the other terminal to a wire or capacity area placed at a height above the ground, and in also connecting at the receiving end one terminal of the coherer to earth and the other to an elevated conductor —Figs 2 and 3 I then began to examine the relation between the distance at which the transmitter could affect the receiver, and the elevation of the capacity areas above the earth, and I very soon definitely ascertained that the higher the wires or capacity areas the greater the distance over which it was possible to telegraph

Thus I found that when using cubes of tin about 30 cms. side as elevated conductors or capacities, placed at the top of poles 2 meters high, I could receive signals at 30 meters distance, and when placed on poles 4 meters high at 100 meters, and at 8 meters high at 400 meters. With larger cubes 100 cms. side, fixed at a height of 8 meters, signals could be transmitted 2,400 meters all around.[1] These experiments were continued in England, where, in September, 1896, a distance of 1¾ miles was obtained in tests carried out for the British government at Salisbury. The distance of communication was extended to four miles in March, 1897, and in May of the same year to nine miles. Tape messages obtained during these tests, signed by the British government officers who were present, are exhibited. In all these experiments a very small amount of elec-

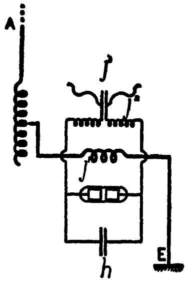


FIG. 6.

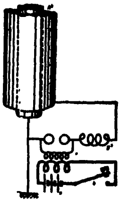


FIG. 7.

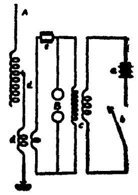


FIG. 8.

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* Address delivered in Stockholm by Mr. Marconi on the occasion of the awarding of his share of the Nobel prize.

[1] See "Journal" of the Institution of Electrical Engineers, London, 1899. Vol. XXVIII., page 278.

trical power was used, the high-tension current being produced by an ordinary Rhumkorff coil The results obtained attracted a good deal of public attention at the time, such distances of communication being considered remarkable

As I have explained, the main feature in my system consisted in the use of elevated capacity areas, or vertical wires, attached to one pole of the high frequency oscillators and receivers, the other pole of which was earthed The practical value of this innovation was not understood by many physicists for quite a considerable period, and the results which I obtained were by many erroneously considered simply due to efficiency in details of construction of the receiver, and to the employment of a large amount of energy Others did not overlook the fact that a radical change had been introduced by making these elevated capacities and the earth form part of the high-frequency oscillators and receivers Prof. Ascoli, of Rome, gave a very interesting theory of the mode of operation of my transmitters and receivers in the Elettricista (Rome) issue of August, 1897, in which he correctly attributed the results obtained by the use of elevated wires or antennæ. Prof A Slaby, of Charlottenburg, after witnessing my tests in England in 1897, came to somewhat similar conclusions[2]

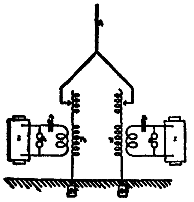

FIG 9.

Many technical writers have stated that an elevated capacity at the top of the vertical wire is unnecessary This is true if the length or height of the wire is made sufficiently great, but as this height may be much smaller for a given distance if a capacity area is used, it is more economical to use such capacities, which now usually consist of a number of wires spreading out from the top of the vertical conductor.

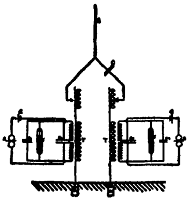

FIG 10.

The necessity or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not connected to earth By "connecting to earth" I do not necessarily mean an ordinary metallic connection as used for ordinary wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground—Fig. 4. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and, therefore, in these cases the earth is for all practical purposes connected to the antennæ. After numerous tests and demonstrations in Italy and in England over distances varying up to 40 miles, communication was established for the first time across the English Channel between England and France in March, 1899.[3] (Fig. 5.)

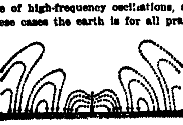

FIG. 11.

From the beginning of 1898 I had practically abandoned the system of connection shown in Fig 2, and instead of joining the coherer or detector directly to the aerial and earth, I connected it between the ends of the secondary of a suitable oscillation transformer containing a condenser and tuned to the period of the electrical waves received The primary of this oscillation transformer was connected to the elevated wire and to earth—Fig 6 This arrangement allowed of a certain degree of syntony, as by varying the period of oscillation of the transmitting antennæ it was possible to send messages to a tuned receiver without interfering with others differently syntonized.[4]

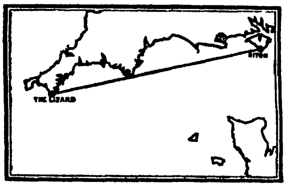

FIG 12

As it is now well known, a transmitter consisting of a vertical wire discharging through a spark gap is not a persistent oscillator—the radiation it produces is strongly damped Its electrical capacity is comparatively so small and its capability of radiating energy so large that its oscillations decrease or die off with great rapidity In this case receivers or resonators of a considerably different period or pitch are likely to be affected by it Early in 1899 I was able to improve the resonance effects obtainable by increasing the capacity of the elevated wires by placing adjacently to them earthed conductors, and inserting in series with the aerials suitable inductance coils[5] By these means the energy storing capacity of the aerial was increased, whilst its capability to radiate was decreased, with the result that the energy set in motion by the discharge formed a train or succession of feebly damped oscillations A modification of this arrangement, by which excellent results were obtained, is shown in Fig 7

In 1900 I constructed and patented transmitters which consisted of the usual kind of elevated capacity area and earth connection, but these were inductively coupled to an oscillation circuit containing a condenser, an inductance and a spark gap, the conditions which I found essential for efficiency being that the periods of electrical oscillation of the elevated wire or conductor should be in time or resonance with that of the condenser circuit—Fig 8[6]. The circuits, consisting of the oscillating circuit and radiating circuit, were more or less closely "coupled" by varying the distance between them By the adjustment of the inductance inserted in the elevated conductor and by the variation of the capacity of the condenser circuit

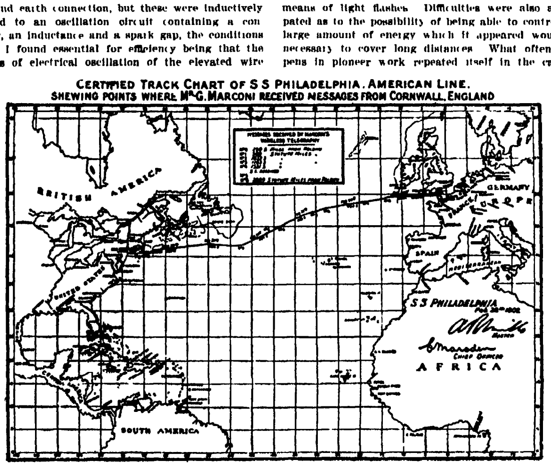
CERTIFIED TRACK CHART OF S S PHILADELPHIA. AMERICAN LINE.
SHEWING POINTS WHERE Mr G. MARCONI RECEIVED MESSAGES FROM CORNWALL, ENGLAND
BRITISH AMERICA
UNITED STATES
GERMANY
EUROPE
FRANCE
SPAIN
MEDITERRANEAN
S S PHILADELPHIA
AFRICA
SOUTH AMERICA

FIG 14.

the two circuits were brought into resonance a condition which, as I have said, I found essential in order to obtain efficient radiation

Part of my work regarding the utilization of condenser circuits in association with the radiating antennæ was carried out simultaneously to that of Prof. Braun, without, however, either of us knowing at the time anything of the contemporary work of the other

A syntonic receiver has already been shown in Fig 6, and consists also of a vertical conductor or aerial, connected to earth through the primary of an oscillation transformer, the secondary circuit of which included a condenser and a detector, it being necessary that the circuit containing the aerial and the circuit containing the detector should be in electrical resonance with each other, and also in tune with the periodicity of the electric waves transmitted from the sending station It is also possible to couple to one sending conductor several differently tuned transmitters, and to a receiving wire a number of corresponding receivers, as is shown in Figs 9 and 10 each individual receiver responding only to the radiations of the transmitter with which it is in resonance

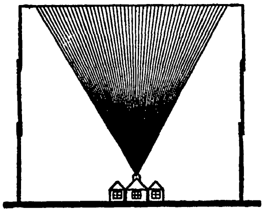

FIG 13.

At the time (eleven years ago) when communication was first established by means of radiotelegraphy between England and France, much discussion and speculation took place as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a somewhat general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long distance transmission, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of light flashes Difficulties were also anticipated as to the possibility of being able to control the large amount of energy which it appeared would be necessary to cover long distances What often happens in pioneer work repeated itself in the case of radiotelegraphy—the anticipated obstacles or difficulties were either purely imaginary or else easily surmountable, but in their place unexpected barriers manifested themselves, and recent work has been mainly directed to the solution of problems presented by difficulties which were certainly neither expected nor anticipated when long distances were first attempted

With regard to the presumed obstacle of the curvature of the earth, I am of opinion that those who anticipated difficulties in consequence of the shape of our planet had not taken sufficient account of the particular effect of the earth connection to both transmitter and receiver, which earth connection introduced effects of conduction which were generally at that time overlooked Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effect of free Hertzian radiation through space and it was years before the probable effect of the conductivity of the earth between the stations was satisfactorily considered or discussed

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[2] See A. Slaby, "Die Funkentelegraphie," Berlin, 1897, Verlag von Bronhard Simion; also A. Slaby, "The New Telegraphy," the Century Magazine, April, 1898, Vol LV, page 867

[3] See Journal of the Institution of Electrical Engineers, 1899, London, Vol. XXVIII., p. 291.

[4] British Patent No 12326 of June 1st, 1898; also No 6982 of April 1st, 1899

[5] See "Etat Actuel et Progres de la Telegraphie sans Fil" by A Blondel and G. Ferrie, read at the Congress International d'Electricite, Paris, 1900, also "Journal" of the Society of Arts, 1901, Vol XLIX, page 509

[6] See British Patent No 7777 of 26th of April, 1900, also "Journal" of the Society of Arts, Vol XLIX, May 17th, 1901, page 510 511.

Lord Rayleigh in referring to transatlantic telegraphy stated in May 190[illegible] The remarkable success of Marconi in signalling across the Atlantic suggests a more decided bending or diffraction of the waves round the protuberant earth than had been expected and it imparts a great interest to the theoretical problem

Prof J A Fleming in his book on The Principles of Electric Wave Telegraphy gives diagrams showing what is now believed to be the diagrammatic representation of the detachment of semiloops of electric strain from a simple vertical wire Fig 11 As will be seen the waves do not propagate in the same manner as free radiation from a classical Hertzian oscillator but glide along the surface of the earth

Prof Fleming further states in the above quoted work The view we here take is that the ends of the semiloops of electric force which terminate perpendicularly on the earth cannot move along unless there are movements of electrons in the earth corresponding to the wave motions above it From the point of view of the electronic theory of electricity every line of electric force in the ether must be either a closed line or its ends must terminate on electrons of opposite sign If the end of a line of strain abuts on the earth and moves there must be atom to atom exchanges of electrons or movements of electrons in it We have many reasons for concluding that the substances we call conductors are those in which free movements of electrons can take place Hence the movements of the semiloops of electric force outwards from an earthed oscillator of Marconi Aerial is hindered by bad conductivity on the surface of the earth and facilitated over the surface of a fairly good electrolyte such as sea water

Prof Zenneck has carefully examined the effect of earthed transmitting and receiving aerials and has endeavored to show mathematically that when the lines of electrical force constituting a wave front pass along a surface of low specific inductive capacity such as the earth they become inclined forward their lower ends being retarded by the resistance of the conductor to which they are attached It therefore seems well established that wireless telegraphy as practiced at the present day is dependent for its conductivity of the earth and that the difference in operation over long distances on the conductivity between the surface of the sea and land is sufficient to explain the increased distance obtainable with the same amount of energy in communicating over sea as compared to over land

I carried out some tests between a shore station and a ship at Poole in England in 1902 for the purpose of obtaining some data on this point and I noticed that at equal distances a perceptible diminution in the energy of the received waves always occurred when the ship was in such a position as to allow a low spit of sand about 1 kilometer broad to intervene between it and the land station I, therefore believe that there was some foundation for the statement so often criticised which I made in my first English patent of June 2d 1896 to the effect that when transmitting through the earth or water I connected one end of the transmitter and one end of the receiver to earth

In January 1901 some successful experiments were carried out between two points on the South Coast of England 186 miles apart i e St Catherine s Point Isle of Wight and the Lizard in Cornwall —Fig 12 The total height of the stations above sea level did not exceed 100 m whereas to clear the curvature of earth a height of more than 1 660 m at each end would have been necessary The results obtained from these tests which at the time constituted a record distance seemed to indicate that electric waves produced in the manner I had adopted would most probably be able to make their way round the curvature of the earth and that therefore even at greater distances such as those dividing America from Europe the factor of the earth s curvature would not constitute an insurmountable barrier to the extension of telegraphy through space

The belief that the curvature of the earth would not stop the propagation of the waves and the success obtained by syntonic methods in preventing mutual interference led me in 1900 to decide to attempt the experiment of testing whether or not it would be possible to detect electric waves over a distance of 4 000 kilometers which if successful would immediately prove the possibility of telegraphing without wires between Europe and America The experiment was in my opinion of great importance from a scientific point of view and I was convinced that the discovery of the possibility to transmit electric waves across the Atlantic Ocean and the exact knowledge of the real conditions under which telegraphy over such distances could be carried out would do much to improve our understanding of the phenomena connected with wireless transmission The transmitter erected at Poldhu on the coast of Cornwall was similar in principle to the one I have already referred to but on a very much larger scale than anything previously attempted" The power of the generating plant was about 25 kilowatts

Numerous difficulties were encountered in producing and controlling for the first time electrical oscillations of such power In much of the work I obtained valuable assistance from Prof J A Fleming Mr R N Vyvyan, and Mr W S Entwistle My previous tests had convinced me that when endeavoring to extend the distance of communication it was merely sufficient to augment the power of the electrical energy of the sender but that it was also necessary to increase the area or height of the transmitting and receiving elevated conductors As it would have been too expensive to employ vertical wires of great height I decided to increase their number and capacity which seemed likely to make possible that efficient utilization of large amounts of energy The arrangement of transmitting antenna which was used at Poldhu is shown in Fig 13 and consisted of a fan like arrangement of wires supported by an insulated stay between masts only 48 meters high and 60 meters apart These wires converged at the lower end and were connected to the transmitting apparatus in a building

For the purpose of the test a powerful station had been erected at Cape Cod near New York but the completion of the arrangements at that station were delayed in consequence of a storm which destroyed the masts and antennas I therefore decided to try the experiments by means of a temporary receiving station erected in Newfoundland to which country I proceeded with two assistants about the end of November 1901

The tests were commenced early in December 1901 and on the 12th of that month the signals transmitted from England were clearly and distinctly received at the temporary station at St John s in Newfoundland Confirmatory tests were carried out in February 1902 between Poldhu and a receiving station on the steamship 'Philadelphia of the American Line On board this ship readable messages were received by means of a recording instrument up to a distance of 1 551 miles and test letters as far as 2 099 miles from Poldhu—Fig 14

The tape records obtained on the Philadelphia' at the various distances were exceedingly clear and distinct as can be seen by the specimens exhibited

These results although achieved with imperfect apparatus were sufficient to convince me and my co workers that by means of permanent stations and the employment of sufficient power it would be possible to transmit messages across the Atlantic Ocean in the same way as they were sent over much shorter distances The tests could not be continued in Newfoundland owing to the hostility of a cable company which claimed all rights for telegraphy whether wireless or otherwise in that colony

(To be continued)

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* [illegible] Proceedings of the Royal Society Vol [illegible] May [illegible] 1903

* [illegible] published by Longmans Green and Co London 1906

* [illegible] Zenneck Annalen der Physik [illegible] 5 p 846 September 1908 Physikal Zeitschrift [illegible] p [illegible] No 17

* Journal of the Society of Arts London Vol XLIX page 1[illegible] 1901

* Royal Institution of Great Britain Lecture by G Marconi June 13th 1902

ELECTRIC VALVES

Now that the use of higher voltages for bulk supply is becoming more general the question of protection of electrical plant against damage due to resonance surges in underground lines and atmospheric disturbances as well as in overhead lines which for commercial reasons are likely to become more common in the near future is one that electrical engineers should turn their attention to at the present time

Where trouble has already occurred in central stations it has generally been put down to faulty design or bad insulation of the machines There is no doubt, however that the damage is caused very often by the setting up—owing to a short circuit or the sudden action of the automatic fuse of a serious rise of potential which is stored in the windings of the alternator and can only flow off through the capacity of the transformer or by perforating the insulation Such voltages rapidly deteriorate the insulation of sunk windings and so it becomes necessary to find some means of overcoming this difficulty Two such pieces of apparatus are now available and may be used in conjunction with each other or separately according to the conditions controlling the line area of distribution capacity of plant etc and are known as the electric valve' and Moscicki condenser

The electric valve consists of a number of spark gaps arranged as follows The first spark gap is placed in series with a sufficiently high resistance so as to avoid high frequency oscillations and the remaining spark-gaps are indirectly connected to earth through small condensers the last spark electrode being connected direct to earth The spark gaps are formed between the edges of sharp round disks of non arcing metal insulated from each other and from the earth connection The capacity required is obtained by these disks and a central rod which is connected to earth and also acts as a support for the disks which are insulated from it The resistance in series with these disks is a metallic one and obviates the trouble usually due to high resistances of graphite or carborundum

The first spark gap is adjustable and is inclosed in a glass cylinder Six or more sets of spark gaps are connected in parallel —each through a high tension fuse— to a common disk which acts as one pole while the cast iron base to which the columns are bolted acts as the other pole The columns are protected from dust and damage by a glass cylinder, which rests on rubber pads on the cast iron base and is protected on top by an insulated cover

The characteristics of the electric valve may be summed up as follows (1) absolute prevention of high frequency currents (2) unlimited capacity for dealing with any energy (3) the adjustable spark gaps being inclosed in glass cylinders there is no likelihood of dust getting between the knobs and causing premature action of the apparatus, (4) the automatic extinction of the arc (5) erection or dismounting very rapid

The Moscicki condenser resembles an extremely long Leyden jar with the difference that the neck of the jar—where the coatings end is considerably thickened The coatings are produced by a chemical silvering process and a heavy deposit on both the inside and outside of the jar is obtained which is further strengthened and protected by a copper deposit The jaws are then mounted in a tin or brass tube, on the top of which a high tension insulator is arranged and carries the contact connected to the inner coating The outer coating is connected to the metal tube and the intermediate space is filled with a mixture of glycerin and water It is then hermetically sealed and consequently the condenser can be used in any position Glass is used for the dielectric owing to its great dielectric capacity and uniformity

The usual type of condenser as used for line protection consists of a number of tubes, as described above mounted on a wrought iron frame, and the inner coatings are connected in parallel through high tension fuses to a common terminal, to which the line is connected The outer coatings are connected to the tin or brass tubes, and connected to earth by means of the framework, which is so arranged that each tube can be easily replaced or removed when it is necessary —Nature

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JEWELERS' WAX.

To make jewelers wax take common rosin and heat it in a vessel until it flows freely, then add plaster of Paris stirring continually while adding the powder Care should be taken not to make the mixture too stiff When it appears of the proper consistency pour some of it on a slate or marble slab and allow it to cool, then insert the point of a knife under the flattened cake thus formed and try to pry it off If it springs off with a slight metallic ring, the proportions are right, if it is gummy and ductile there is too much rosin if it is too brittle and crumbles this indicates that there is too much plaster

This is what is sold for jewelers' cement It is used for filling gold headed canes, umbrella handles, cementing stones in ring settings and also for holding very thin pieces of metal on a faceplate for drilling cutting disks, or turning off the surface I gave this formula to a friend who had some very artistic tile for a fireplace and after having set as many as he could one evening he forgot that the wax only needed rewarming in order to use it the next day so in order to keep it fresh he poured water in the iron pot In the morning the wax had become insoluble, owing to the action of the water on the plaster So it is advisable not to wet the wax until it is put to its final use and place —Machinery

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A safety lamp for detecting small percentages of firedamp without lowering the flame of the lamp, has been invented by two English engineers The inventors recently gave a demonstration with the new lamp, showing how the introduction of sodium carbonate into the flame—by means of a piece of asbestos saturated with it—converted the blue cap, produced by gas, into a bright yellow flame, without lowering the lamp flame.

HALLEY'S COMETARY STUDIES.

HIS OWN ACCOUNT OF HIS INVESTIGATIONS ON ORBITS.

HALLEY'S treatise, which bore the title 'Astronomiæ Cometicæ Synopsis,' (i e A Synopsis of the Astronomy of Comets) was presented to the Royal Society in 1705, and was published in 1706 in volume 24 of the Society's Transactions page 1882 1899 The following account of this work is taken from Volume IV of Baddam's abridgment of the Memoirs of the Royal Society (London 1739) The original spelling and punctuation are retained here

The ancient Egyptians and Chaldeans (if we may credit Diodorus Siculus) being furnished with a long series of observations, could predict the rising or appearing of comets but since they also are said by the same arts to have foretold earthquakes and tempests, it is past all doubt that their knowledge in these matters was rather the result of astrological calculations than of astronomical theories of the motions of the celestial bodies and the Greeks, who were the conquerors of both these nations scarcely found any other sort of learning among them than this so that it is to the Greeks themselves as the inventors especially to the great Hipparchus that we owe this astronomy which is now so greatly improved but Aristotle's opinion (viz that comets were nothing else than sublunary vapors or airy meteors) prevailed so far amongst the Greeks that this sublimest part of astronomy lay altogether neglected since none could think it worth while to observe and give an account of the wandering and uncertain paths of vapours floating in the Æther, whence it is that we have nothing certain handed down from the ancients concerning the motion of comets but Seneca the philosopher, considering the Phænomena of two remarkable comets of his time made no scruple to place them amongst the celestial bodies taking them to be stars of equal duration with the world itself tho he owns, that their motions were regulated by laws not then discovered at length, he foretells (which has proved no vain prediction) that time and diligence would unfold these mysteries to some future ages who would be surpris'd how the ancients could be so ignorant of them after that some lucky interpreter of nature would have pointed out in what parts of the heavens comets wandered and shewn what and how great they were, yet almost all astronomers differed from Seneca in this and Seneca himself has not left any account of the Phænomena of the motion whereby he might support his hypothesis nor assigned the time of their appearing which might enable posterity to determine anything in this matter So that after Mr Halley had turned over several histories of comets he could find nothing at all that could give any assistance herein, before A D 1337 when Nicephorus Gregoras, an historian and astronomer of Constantinople had pretty accurately described the path of a comet amongst the fixed stars, but he too loosely assigns the time so that this undermined comet only deserved to be inserted in the catalogue on account of its having appeared almost 400 years ago, the next comet A D 1472, which moved the swiftest of all and came nearest to the earth was observed by Regiomontanus, this comet (so frightful on account both of the magnitude of its body and its tail) in the space of a day moved 40 deg of a great circle in the heavens and it is the very first of which, any proper observations have been handed down to us for all those who considered comets before Tycho Brahe that great restorer of astronomy supposed them to be below the moon and so took but little notice of them imagining them to be no other than vapours But in the year 1577 Tycho Brahe applying himself seriously to the study of astronomy and having procured large instruments for making celestial mensurations, with greater exactness and certainty than the ancients could ever hope for, there appeared a pretty remarkable comet to the observation of which Tycho vigorously applied himself, and he found by several unquestionable trials, that it had no sensible diurnal parallax, and consequently, that it was not only no aerial vapour, but much higher than the moon, nay and might be reckoned amongst the planets for anything that appeared to the contrary, notwithstanding the cavilling opposition of some schoolmen, to Tycho succeeded the sagacious Kepler, who having the advantages of Tycho's observations, found out the true and physical system of the world, and vastly improved astronomy, for he demonstrated, that all planets revolved in planes passing through the centre of the sun, and describing elliptical curves, observing this law, that the area's of the elliptic sectors taken at the centre of the sun, in the Focus of the ellipsis, are always proportional to the times, wherein the corresponding arches are described; he also discovered, that the distances of the planets from the sun are in the sesquilateral ratio of their periodical times or that the cubes of the distances are as the squares of the times this great astronomer had the opportunity of observing two comets one of which was very remarkable and from his observations of these, he concluded from several indications of an annual parallax that comets move freely thro planetary orbits with a motion not much different from a rectilinear one but which he could not determine Next Hevelius a noble emulator of Tycho following Kepler's steps embraced the same hypothesis of the rectilinear motion of comets he himself having very accurately observed several of them yet he complained that his calculations did not altogether agree with the appearances in the heavens and he was aware that the path of comets was incurvated toward the sun At length that extraordinary comet of 1680 descended from a vast distance and as it were, in a perpendicular line toward the sun and ascended from him again with an equal velocity this comet appearing constantly for four months by the peculiar and remarkable curvity of its orbit seemed above all others the most adapted for investigating the theory of their motion and the Royal observatories at Paris and Greenwich being founded some time before and committed to the care of the most famous astronomers the apparent motion of this comet was (as far as human sagacity could reach) very accurately observed by M Cassini and Mr Flamstead Not long after that incomparable geometrician Sir Isaac Newton not only demonstrated that what Kepler had found, did necessarily obtain in the planetary system but likewise that all the Phænomena of comets plainly follow from the same principles which he fully illustrated by the abovementioned comet of 1680 and at the same time shewed the way of geometrically constructing the orbits of comets and to the surprise of all men solved a problem whose intricacy rendered it worthy of so great a genius and he proves that this comet revolved round the sun in a parabolic orb in such a manner that the areas estimated at the centre of the sun were proportional to the times Mr Halley pursuing the steps of so great a man attempted (and he presumes not without success) to bring the same method to an arithmetical calculation for having collected together all the observations of comets he obtained the following table the result of almost immense calculation

The Astronomical Elements of the Motions in a Parabolic Orbit of All the Comets Hitherto Obtained

Passage of Perihelion Equal Time		d	h	m	Longitude of Perihelion		Longitude of Asc Node		Inclination of Orbit		Distance from Sun at Perihelion
							°				
1337	June	2	6	25	37	59	84	21	32	11	0 40666
1472	February	28	22	23	47	34	281	46	5	20	0 54273
*1531	August	24	21	18	301	39	49	25	17	56	0 56700
1532	October	19	22	12	111	7	80	27	32	36	0 50910
1556	April	11	1	28	278	50	175	42	32	6	0 46390
1577	October	26	18		129	22	25	52	74	32	0 18342
1580	November	28	15	00	109	6	18	57	64	40	0 59628
1585	September	27	19	20	8	51	37	42	6	4	1 09358
1590	January	29	3	45	216	54	225	31	29	41	0 57661
1596	July	31	19	55	228	15	312	12	55	12	0 51293
*1607	October	16	3	50	302	16	50	21	17	2	0 58680
1618,	October	29	12	23	2	14	76	1	37	34	0 37975
1652	November	2	15	40	28	19	88	10	79	28	0 84750
1661	January	16	23	41	115	58	82	30	32	36	0 44851
1664,	November	24	11	52	130	41	81	14	21	18	1 02576
1665	April	14	5	15	71	54	228	2	76	5	0 10649
1672	February	20	8	37	46	59	297	30	83	22	0 69739
1677	April	26	00	37	137	37	236	49	79	3	0 28059
1680	December	8	00	6	262	40	272	2	60	56	0 00612
*1682	September	4	7	39	302	52	51	16	17	56	0 58328
1683,	July	3	2	50	85	30	173	23	83	11	0 56020
1684	May	29	10	16	238	52	268	15	65	48	0 96015
1686	September	6	14	33	77	0	350	35	31	22	0 32500
1698	October	8	16	57	270	51	267	44	11	46	0 69129

Those marked with a star (*) are successive apparitions of Halley's Comet

[Then follows a general table to compute the Motion of Comets in a parabolic Orbit together with an explanation of its construction and use]

It is to be observed that the five first comets the third and fourth of which was seen by Petrus Apianus, and the fifth by Paulus Fabricus, as was the tenth by Mestlinus in the year 1596, have not the same degree of certainty with the rest the observations not having been made with the proper instruments or the necessary exactness and therefore disagreeing with each other they can by no means be reconciled with a regular calculation Blanchini alone observed at Rome the comet Anno 1684 and the astronomers at Paris the last comet in 1698 whose path they have described in an unusual manner this very obscure comet, tho' swift and pretty near the earth, escaped our observations Mr Halley forbore to insert into his catalogue the two remarkable comets that appeared the one in November 1689 and the other in February 1702 for want of observations for directing their course towards the southern part of the world and their being scarcely visible in Europe they were not observed by persons equal to the task It is to be observed that 11 of the comets in Mr Halley's catalogue move direct i e according to the order of the signs viz those in the years 1[illegible] 1580 1585 1618 16[illegible] 1661 16[illegible] 1680 1682 and 1686 and that the other 13 were retrograde i e moved contrary to the order of the signs

Upon weighing all these things and comparing the rest of the elements of the motions of these comets with each other it will appear that their orbits are disposed in no certain order and that they are not confined like the planets to the zodiac but that they move indifferently every way both retrograde and direct whence it is plain that they are not moved by Vortices the distances of their Perihelia are found to be sometimes greater and sometimes less whence we have reason to suspect that there are a great many more comets which being at remote distances from the sun and being obscure and without a tail may for that reason escape our observation

We have hitherto considered the orbits of comets as perfectly parabolic from which supposition it would follow that comets being impelled by a centripetal force toward the sun descend from infinite distances and by their fall acquire so great a velocity as to convey them into the remotest spaces of the system and by a perpetual Nisus tending upward never afterward to return again to the sun seeing then that the appearing of comets is very frequent and that none of them is found to move in an hyperbola or with a greater velocity than it would acquire in falling toward the sun it is more credible that they revolve about the sun in very excentric orbits and return after very long periods for thus their number is definite and perhaps not so very great and the spaces between the sun and the fixed stars are so immense that there is room for a comet to perform its period however large it may be for the Latus rectum of an ellipsis is to the Latus rectum of a parabola having the same Perihelian distance as the Aphelian distance in the ellipsis is to its whole axis but the velocities are in the subduplicate ratio of the same wherefore in very excentric orbits this ratio approaches very nearly to a ratio of equality and the small difference which arises on account of the greater velocity in a parabola is very easily compensated in determining the situation of the orbit therefore the principal use of the elements of the motions in this table is that whenever a new comet appears we may by computing the elements know whether it is one of those that formerly appeared and consequently we may determine its period and the axis of its orbit and foretell its return and Mr Halley tells us that he had several reasons to induce him to believe that the comet in 1531 which was observed by Apian was the same with that described in 1607 by Kepler and Longomontanus, and which he himself had seen and observed upon its return again in 1682 all the elements agree and there is no other difference than the inequality of their periods which yet is not so considerable as that it may not be ascribed to physical causes for Saturn's motion is disturbed in such a manner by the other planets especially Jupiter that its periodical time is for some whole days uncertain how much more may a comet be subject to such irregularities whose orbit rises almost four times higher than Saturn's and whose velocity tho never so little augmented may change its orbit from an ellipsis to a parabola that it was the same comet is farther confirmed from that observed in the summer of 1456 to pass retrograde almost in the same manner between the sun and the earth which tho it was not observed astronomically by any yet Mr Halley conjectures that was the same with the former from its period and the manner of its transit whence he ventures to foretell its return in 1758 and if this happens there will be no further cause to doubt but that the rest may likewise return astronomers will therefore have a large field to exercise themselves in for several ages, before they can determine the number of so many and so great bodies that revolve round the common centre of the sun and reduce their motions to certain rules Mr Halley was apt to believe that the comet of 1532 was the same as that observed by Hevelius in the beginning of 1661 but Apian's observations which are the only ones we have are too inaccurate to determine anything certain from them in so nice an affair Sir Isaac Newton delivers a method of constructing the orbits of comets by three accurate observations, Philos. Natural. Princip Mathemat lib III which afterwards Dr Gregory fully and clearly illustrated in the fifth book of his physical and geometrical astronomy

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* Journal of the Royal Astronomical Society of Canada.

Here one thing is to be observed, viz, that some of these comets have their nodes so near the annual orbit of the earth, that should it happen at the time of the return of a comet, that the earth was near its node, whilst the comet passes with an incredible velocity, it would also have a very sensible parallax, and which would be to the sun's parallax in a given ratio, whence, upon such like transits, there would be a very favorable opportunity (which yet seldom happens) of determining the distance of the sun from the earth, which hitherto could be concluded but very loosely, and that only by means of the parallax of Mars in opposition to the sun, or that of Venus in the Perigaeum and tho' indeed it is thrice greater than the parallax of the sun, yet it is scarcely perceptible with any instrument, and this use of comets was suggested by the famous geometrician Nio Facia, for the comet of the year 1172 had a parallax 20 times greater than that of the sun, and had the comet Anno 1618 arrived, about the middle of March at its descending node, or had the Comet Anno 1864 come a little sooner to its ascending node, being very near the earth they would have had still more sensible parallaxes, of all the comets there were none that approached nearer the earth than Anno 1680, for, upon a calculation, it was no further distant towards the north from the annual orbit, than the sun's semi diameter (or the radius of the moon's orbit, as Mr Halley suppose) and that too in November 10th 1 hr. 6 min P M., at which time it had been in conjunction with the earth as to longitude, there might have been observed in its motion a parallax equal to that of the moon Mr Halley leaves it to philosophers to discuss what consequences would arise from the appulse, contact or collision of the celestial bodies, which yet is not altogether impossible

THE CHINESE CALENDAR.

To the Editor of the SCIENTIFIC AMERICAN

IN my article on the Chinese calendar in the preceding issue of SCIENTIFIC AMERICAN SUPPLEMENT, pages 114 and 115, I did not refer to the fact that the sexagenary cycle was used for days as well as for years by China That is to say, the days are named and numbered in continuous groups of sixty, and as this method does not synchronize with the days of the month, or moon, it leads to a curious mixture of dates that often puzzle historians For example, the current native almanacs from China show the first day of the first month quite correctly, but just below these dates the reader finds the stem and branch characters which indicate the sexagenary day It may be anywhere from Kiah Tsu to Kwei Hai (1st to 60th day) It so happens that the current Chinese year began on the day known as Ping-Woo, or 43d day It, therefore follows that the 18th day of the month will be the 60th day Then the next day, the 19th of the month, will be day first This makes the first Chinese month end on Kiah Suh or the 11th day of the next cycle of 60 days In other words, this first Chinese month, which begins with the first day and ends with the 29th in the monthly order, also begins (strange as it may sound) on the 43d day and ends on the 11th day.

As Japan used this same system until a comparatively recent time many Japanese calendar clocks in our museums and private collections contain this 60-day feature As many owners of these artistic timepieces do not know what the characters mean, it was thought best to bring this point out clearly Both China and Japan now use our clocks and watches, and Japan has adopted our Gregorian calendar But China adheres to her ancient method of counting her days.

Just one more little point Near the end of the article I speak of a "sidereal lunation" Please read this sidereal month This is a period of time between 27 and 28 days, and ancient records show that a lunar zodiac of these numbers of lunar mansions or domiciles were used, but the later figure was favored because it was capable of being quartered into periods of 7 days It is, therefore, my firm opinion that this fact fixed our 7 day week and that these 7 days came under the influence of, or were later named after the sun, moon, and five of the planets thus pushing the origin of the Jewish Sabbath and the Christian Sunday very far back Modern skygazers who have had the chance to see the moon and stars in the clear atmosphere of the East can realize how natural it was that these early calendar constructors should mark off the moon's zone of action into a stellar dial of 28, sometimes by single stars equally spaced, at other times by groups of stars not so well placed This slightly arbitrary but even number (28) being divisible by the much used 4, which was more or less connected with the four cardinal points of the compass, the four corners of the world, the four seasons, and so on, made the creation of the 7-day period a most logical and natural step. DANIEL ARTHUR.

New York, N. Y.

SCIENCE NOTES

A bulletin of the University of California announces the discovery of further proof of the identity of heliotropism in animals and plants The new results were obtained by Professors Loeb and S S Maxwell Since fish and Daphnia are too large to allow very exact determinations of the relative heliotropic effect of the different parts of a spectrum, experiments were also made with a smaller form of animals, namely, the newly hatched nauplii of Balanus perforatus, which they were able to obtain in unlimited quantities These animals possess the most intense positive heliotropism of any form thus far found The frequency curve for the distribution of these animals in the spectrum gave the maximal density of the gathering in the freen, the highest ordinate being possible toward the yellowish green Experiments proved that the heliotropic reactions of swimming animals are identical with those of swimming algæ.

Dr. Franz Fischer has discovered that when air is heated under certain conditions there is formed ozone If we heat air to a very high temperature and then cool it quickly down to the normal, this sudden cooling has the effect of producing ozone A Vienna electric firm has constructed an ozone-producing fan on this principle, using a Nernst radiator which gives a heat of 2,000 deg C The fan brings a current of air over the incandescent substance which is fixed, and the air becomes heated and is then cooled by mixing with the surrounding air Ozone is thus formed which is sent out by the air fan. The apparatus consists of a small flywheel and air fan combined which is run by an electric motor, the fan draws in the air and sends it by a funnel shaped vessel into the part containing the Nernst heater The whole apparatus mounted on a base does not weigh more than 30 pounds. About 4 per cent of the oxygen is ozonized, and this amount cannot be exceeded on the present principle, so that there is nothing to fear from a too great amount of ozone One such device will suffice to purify the air of a large hall, and the amount of power used is very low.

In an article published in the Astrophysical Journal Mr W. H. Mitchell says that many of the characteristic features of the sun-spot spectrum appear to be due to the absorption of various oxides and hydrides existing as vapors in the spot regions As most of these are regarded as low temperature products, it is further supposed that water-vapor may also exist on account of the reduced temperature. Unfortunately many of the recorded observations in the region 5,860-6,000 are widely discordant so far as their identification with water vapor lines is concerned, and it is possible that they may really be faint solar lines of other elements so close to the water vapor positions as to be mistaken for them unless very great dispersion is employed Determinations made with a powerful spectroscope at Haverford indicate that the supposed widening of the water-vapor lines in the spot-spectrum band may be a subjective effect caused by the dark umbral background Hale has noted that the water-vapor lines show no evidences of circular polarisation in the sun spot spectrum, suggesting that it is probable that they are unaffected by sun-spot absorption From this it would appear that up to the present we have no definite evidence of the presence of water-vapor in sun-spots.

The London Times reports that a novel method of killing moths and other insects which are harmful to grape vines has been adopted near Rheims. Posts supporting 5-candle-power electric lamps were placed in the vineyards, from each of which a dish, containing water with a top layer of petroleum, was suspended. During the first night these traps were placed in three parallel rows at distances of about 100 feet from each other, the distance between each lamp being about 75 feet. On the first clear evening late in July the current was turned on about eight o'clock, and the lamps remained burning until an hour or so after midnight. Soon after the lamps were lighted the insects swarmed toward them and were rapidly killed, either by the fumes of the petroleum or by the petroleum itself The same operation was resumed the next clear night, but the lamps of the two outside rows were placed about 25 feet closer to those of the center row, and this was repeated in each of five subsequent clear nights, so as finally to bring the three rows within about 50 feet of each other. During the succeeding six or seven clear nights the movement was reversed in the same manner, so as to return the lamps to their position of the first night. As to the position of the lamps, numerous experiments were made during these trials, and it was proved that the greatest number of insects were killed when the petroleum dish was elevated only a few inches above the ground. These experiments were witnessed by representatives from a number of leading champagne makers, and this method was recommended to all wine growers who can avail themselves of the services of electricity.—Science.

TRADE NOTES AND FORMULÆ.

Syndeticon, Liquid Fish Glue.—Dilute 100 parts of concentrated fish glue with 120 parts of acetic acid and dissolve separately 20 parts of gelatine in 120 parts of water Well mix both fluids and add 20 parts of shellac varnish to the mixture, stirring constantly

Zapon Varnish.—Over 2 parts of colorless celluloid waste (obtainable at celluloid factories) pour 20 parts of acetone and allow the mixture to stand for several days in closed vessels with frequent stirring till the whole is dissolved to a clear, thick mass Then add 78 parts of amylacetate and let the varnish settle for some weeks till it is completely clear

Luminous Paint.—Twenty parts non-acid white gelatine, dissolved in 100 parts of water, to this add (dissolved) 3 parts chromate of potash and combine, with 10 parts of thickly liquid white lead or zinc white varnish, as pale as possible, by vigorously stirring into a homogenous mass After thorough stirring incorporate 15 parts of a previously prepared phosphorescent powder.

Universal Spirit Varnish. — To 60 parts each of bleached shellac, crushed Manila copal and mastic and 15 part of Venice turpentine add 1,000 parts of 92-95 per cent. alcohol and some crushed glass and allow the mxiture to stand for 1 to 2 weeks, stirring frequently. Then add about 1 part of boracic acid and filter. The varnish may be used for metal, wood, paper, etc. In aniline colors soluble in alcohol are added to it, the so-called "brilliant varnish" (Brillantlack) is obtained, adapted for varnishing bottles, metal plate and capsules

Paint for Wooden Posts.—Fifty parts of rosin, 40 parts of finely crushed chalk, 500 parts of fine white and sharp sand; 4 parts linseed oil, 1 part natural red oxide of copper, 1 part sulphuric acid First heat the rosin, the chalk, the sand and the linseed oil in an iron pot, then add the oxide, and, with great care, the sulphuric acid; mix all very carefully and by means of a stiff brush, apply to the wood while still hot If the mixture does not appear to be sufficiently fluid, thin it with a little linseed oil When this paint is cold and dry, it constitutes a coating as hard as stone, through which no moisture can penetrate.

Uralite is a fire-proof building material composed of pulverized asbestos wtih the addition of chalk, silicates, sulphuric acid, aluminium sulphate, etc The compound is first pressed, dried and saturated with an adhesive and mineral colors, then pressed into forms, again dried and cut to the desired measure It combines the advantages of stone with those of wood. It is fireproof; does not stretch; does not warp with heat or damp; can be nailed, glued or riveted, is a bad conductor of heat, electricity and sound, and is not sensitive to the action of acids, frost, or of cold and hot water Its weight, it is true, is double that of oak, but it is said to be of peculiar excellence as a weather and fire-proof substance

Zelodelite.—Under this title is recognized a mixture of sulphur and pulverized fragments of stoneware or glass It is best prepared from 19 parts of sulphur and 42 parts of powdered stoneware or glass powder The mass is heated until the sulphur melts when it is mixed by stirring and poured into molds By this means we may make slabs that can be employed in place of lead for the construction of sulphuric acid cells, for the mass withstands the effects of air and acids, no matter how concentrated the latter may be. As it retains its solidity in boiling water and melts only at about 248 deg. F. it is well adapted for various other purposes for which we use asphalt; it even replaces hydraulic lime, as it cements stones together with the greatest tenacity. Where zelodelite is used for the construction of sulphuric acid cells, in place of lead plates, great advantage is obtained, for the substance completely resists the acids. Although plates of 1½ centimeter thickness are used, while the lead plates are but 3 millimeters thick, its cost is but one-fourth that of lead plates and an acid, wholly free from lead, is obtained. To join the plates together they are set 2 centimeters apart and the joints filled with melted zelodelite, heated to 636 deg. F. (300 deg. C.).

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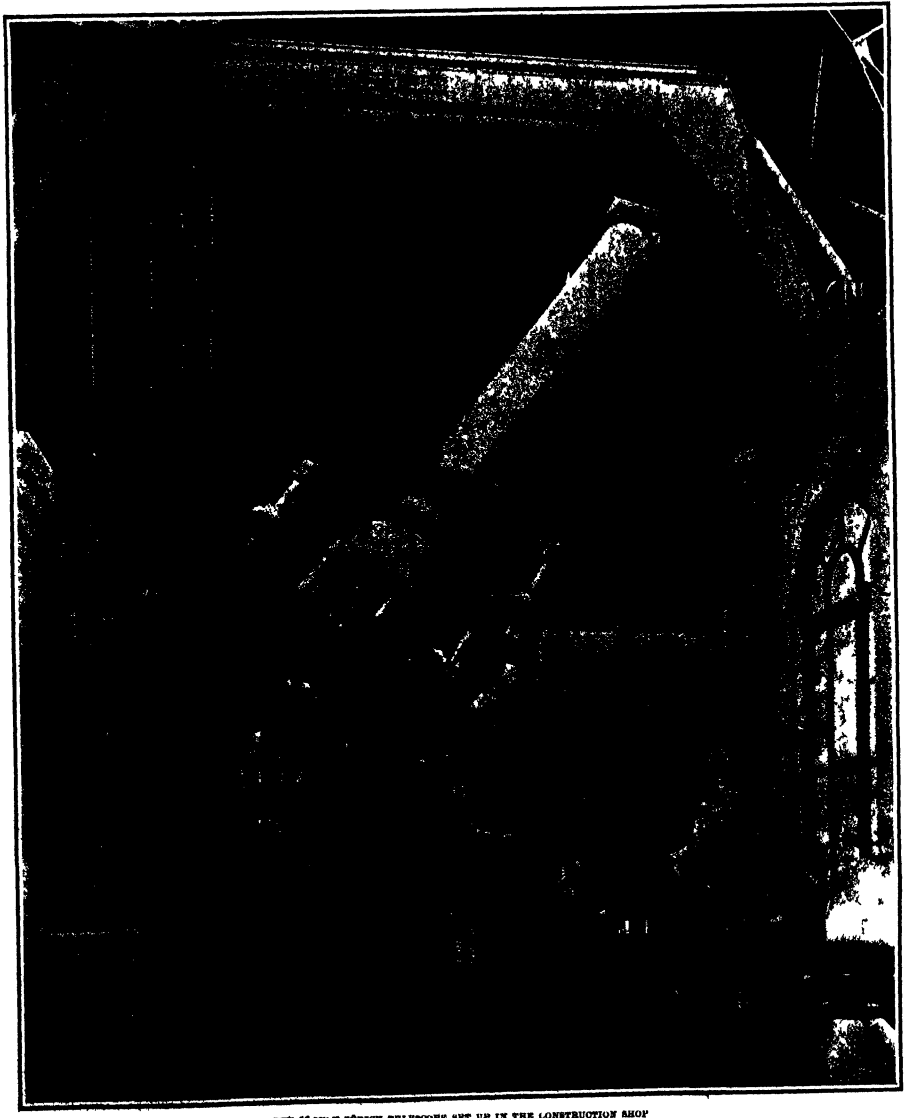

THE 12-INCH ZÜRICH TELESCOPE SET UP IN THE CONSTRUCTION SHOP

THE URANIA ZÜRICH EQUATORIAL TELESCOPE.—[See page 152.]

WHEN THE SUN IS EXTINGUISHED.

WHAT WOULD HAPPEN.

BY DR. M. WILHELM MEYER.

What would we do if one of these days we should notice that the sun will rise no more?

The good housewife will answer. Well, in that case we shall simply switch on the electric light. And even if the sun should go on strike forever, our engineers, those magicians, who can do anything would soon invent something to compensate for this loss. Has not engineering such a reputation nowadays, that nothing is believed to be impossible to it?

The scientist might add right here that nature has invented a light far cheaper than electric light, for instance that emitted by fireflies. And if we have discovered so many of nature's secrets why should not we fathom that of the firefly light? As regards the cheapness of such living lanterns it is interesting to learn that American scientists have recently subjected a lightning bug which emitted a light equal to only 1/1,600 of a candle power to examination with exceedingly delicate instruments capable of measuring almost unbelievably small amounts of radiant energy. They found that this little beetle to produce its light did not expend any amount of energy that they could measure. If this energy had been but one ten-thousandth of that necessary to produce illumination of the same brightness by means of a candle it would have been measurable. The conclusion is that this insect's light is at least ten thousand times cheaper than candle light. All the engineers have to do is to invent it.

Economy however, can be obtained only by avoiding the tremendous waste of heat common to all our sources of light. But we also need the sun's heat. It is true that at times the sun is rather free with his heat, and we flee from his too great liberality. At other times, however, we have to resort to stoves and furnaces. Should not it be possible to invent something that would insure a more even distribution? Could not we become independent of the sun's heat radiation? Do not scientists tell us that the interior of the earth is extremely hot, at least just as hot as the streams of lava pouring from volcanoes? Compared with this almost inexhaustible source of heat contained in the body of our good old mother earth, the few saved up pennies represented by our coal beds are as nothing.

Perhaps this interior heat would suffice for a few hundred thousand years. After all we could dig deeper and deeper into the earth in order to get nearer and nearer to the hot center of our planet. It is probable that the first human beings were cave dwellers who retreated before the ice of the glacial era into these open folds of the earth's crust, where at least a cellar's warmth was obtainable, why should not the last men do the same thing for a like reason, but in their own power and in a much more perfect way than their old time predecessors? The huge heat stored in the earth's interior could be utilized readily for ample lighting especially if we do invent the cheap light. We could build fairy like underground palaces, sparkling with crystals and gems, resplendent in variegated luminous colors, with reflecting galleries of pillars and romantic stalactite structures. Comfortable heat and soft light just as we should like to have it, would fill all rooms. We should walk in woods of trees made of polished, many veined agate, and bearing leaves of silver and gold. The flowers at our feet would be rubies, sapphires, and topazes, and all the wonders with which our childhood's fancy adorned the fairy gardens could there become a reality.

There still remains one doubt, however. Shall we not have to starve amid all this splendor? Up on the surface of the earth it has become cold and dark. But no plant can grow without light, and indeed they cannot do without sunlight. No artificial light has so far been able to take the place of the sun. All animals, and ultimately the human race, live on plants directly or indirectly. The conversion of mineral substances, water and air into edible products could hitherto be effected only by the plant organism in its microscopic retorts. This is another undiscovered secret.

But whenever dire need arose the saving discovery was made. At present we are still able to have the plants cook our food in sunlight, and this fortunate condition is likely to continue for quite some time. Still our shrewdest investigators have long ago begun attempts to make "organic substances," and ultimately bread from stones or at least from air and water with a little bit of earth added. Some success has been achieved already. Unfortunately, everyone of the organic substances so far produced in the chemical laboratory has no nutritive value whatever. We have been able to reproduce artificially the perfumes of flowers, for instance the sweet fragance of the violet, which certainly is one of nature's masterpieces, and also many dyestuffs which heretofore could be derived from plants only. So far, however, there is among these artificial products none of any use to our stomachs. But all this will be achieved some time, and then we shall not need the sun at all, and it may go out if it wishes.

But will this ever occur? Can the sun ever lose its immense power? A calculation has been made showing that the sun is like a furnace capable of heating an engine that could every second lift a load of 30 billion tons (of 2,000 kilogrammes each) a distance of one kilometer. Let the engineers figure what they could do with this, whereas at present they allow all this energy to go to waste. With an infinitesimal portion of this energy the sun sets in motion the machinery of our atmosphere which raises the water from the seas to the clouds and feeds our waterfalls. With small tappings of this water, such as those diverted at Niagara Falls, we light entire cities. This furnace, as could be determined with reasonable certainty, has a surface temperature of about 6,000 deg. C. In its interior the sun must harbor temperatures of perhaps hundreds of thousands of degrees. And from this sun there might be formed more than 300,000 bodies of the earth's size, all of this tremendous heat. It will be apparent that this represents a huge store which is likely to last many millions of years. A rough calculation showed that the sun has been shining upon this earth for about 500 million years and that it ought to continue doing so for another 100 million years, but it must be admitted that these figures rest on insecure foundations. But even if they are ten times too large, we can await developments with some equanimity.

Even nowadays we see signs indicating that some time sunshine and sunbeams will cease. On the sun's beautiful face traces of old age will appear now and then as dark spots which break out in greater or smaller numbers and extent, often suddenly, at other times requiring weeks and months for their development and disappearance. About every eleven years these ugly pock marks break out with particular strength on the brilliant skin of the mighty ruler of our world, every eleven years his body must rid itself of this bad disease, whereupon for a few years the sun may beam again with almost spotless purity and again spread happiness and comfort everywhere with bounteous plenty.

These sun spots are violent whirlwinds in the upper atmosphere regions of the central body of our planetary system, as is evidenced by the very shape of the cloud formations, frequently spiral and storm-swept, which surround the inner apparently quite black nucleus of the spot. Recently the American astronomer Hale, who has made a special study of the sun, has particularly investigated the spectral lines into which the light of the sun spots may be separated, and has shown that in these cyclones there occur tremendous electric discharges the effects of which we may often observe upon the earth in the magnificent polar lights which are frequently seen shooting up when an unusually large sun spot faces the earth. The sun clouds which are whirled about in these frightful thunder storms are frequently so large that the earth's entire surface could be contained in them many hundreds of times, and so hot that iron would be not only liquefied, but transformed into vapors. As a matter of fact it is partly iron air which blows across the surface of the sun and from which a rain of luminous drops falls in the spots, to be again gasified in the lower, hotter strata of the sun and to whirl up from them.

It has been observed that whenever the sun is covered with particularly numerous spots the whole atmosphere of the earth grows cooler one or even two degrees (centigrade). It has further been found that a temperature reduction of only five degrees would suffice to bring back the glacial era in our latitudes, destroying every vestige of life in streams of ice a thousand meters thick.

We therefore really cannot deny that the sun already begins to slowly lose its light. Among the countless fixed stars in the skies, all of them distant suns, there is a large number which periodically lose their light and therefore their heat in a much higher degree; these are called variable stars. Some of them are known to change their light by all sorts of gradations; some require almost as much time for the change as our sun, others become alternately bright and dim within a few hours, some have perfectly regular fluctuations, others flare up and grow dark again without any regularity; some vary but little in magnitude, others may pass from absolute invisibility to the greatest brightness and then vanish again into the night of the universe.

In the same manner, after many fluctuations of this character, our sun will some time have lost all its light and all its heat. But long before this shall have happened, the last glow will have become extinguished in the earth's interior, and with it all life on this dark little star which has been assigned to us as a dwelling place. At the last extremity there will be an absolute failure of all the clever tricks and inventions by which we were able to impress nature into our service in order to keep away from us, for a time, the life-chilling power of the increasing inter stellar cold, which is bound to grip us more and more. In a like manner all those projective devices must finally become exhausted which nature herself has invented for the wonderful organization of the universe, to save her creatures as long as possible from the fate of freezing to death. I have discussed this at greater length in the revised edition of my work on "The End of the World," published in the "Kosmos" series.

But only each particular world or world system, as an individuality, can perish. Everything must die in order to make room for the birth of something better. The end of a world is followed by a new creation. There is an everlasting cycle of life and death, back to new life.—Translated for the Scientific American Supplement from Die Gartenlaube.

WESTWARD MIGRATION OF EARTHQUAKES.

A very interesting theory concerning the apparent westward migration of seismic and volcanic activity has been lately published by H. Wehner, according to Prometheus. According to this view the earthquakes, which apparently appear quite sporadically in weak parts of the earth's crust, are subject to a regular law of distribution. From the examination of numerous lists of earthquakes and volcanic eruptions, Wehner concludes that the tendency to these convulsions move slowly from east to west in every part of the world. From the center of the disturbance this tendency moves westward on the same parallel of latitude with a velocity of about 22 minutes 41 seconds of longitude per year, thus making the circuit of the globe in 952 years. At any place of instability, the danger of an earthquake or volcanic eruption is increased when this migrating tendency to disturbance reaches the spot.

Wehner cites a number of examples to prove the truth of his theory. The earthquake which occurred in 1855 in the vicinity of the Sea of Marmora should have been followed, according to this theory, by outbreaks at weak points lying further westward on the same parallel of latitude, after the expiration of various periods of time. The Gulf of Naples is a weak spot in the earth's crust, 11½ degrees west of the Sea of Marmora; hence an earthquake might have been expected there thirty-eight years after the Marmora earthquake, or in 1893, in which year a violent earthquake actually occurred at Naples. Similarly, from the earthquake of 1880 in Smyrna are deduced the earthquakes of Chios in 1881, Athens in 1886, Corinth in 1888, Zante in 1893, the Ionian Sea between 1893 and 1905, and the great Messina earthquake of 1908. Future shocks of the same series may be expected to occur in 1914 at Palermo, in 1952 at Alicante, and in 1972 on the coast of Portugal. In this series the great earthquakes of Smyrna, Zante and Messina are of special influence. At present there is an unusual danger of earthquake in the vicinity of St. Etienne and Herault in France, in Macedonia, Otranto, Tarentum, Cyprus, and portions of Algeria. This theory is based upon the hypothesis that the kernel of the earth is rigid, and rotates less rapidly than the crust of the earth, and that certain inequalities upon the exterior of this rigid kernel increase the local tendency to earthquakes. This hypothesis is not accepted universally, and it yet remains to be proved that the asserted law of progression will actually suffice.

CROCODILE REMINISCENCES.

LOCAL TALES AND SUPERSTITIONS.

BY A. CAVENDISH.

Fish and dog stories we all know, and are accustomed to swallow with salt to taste; but it is only given to those whose path lies off the beaten track to hear first hand and in the vernacular the inevitable crocodile stories with which the river dweller of the Eastern tropics likes to regale his white guest sitting smoking long native *rokos* in the semi-darkness during the hour between the evening meal and bedtime.

What the fish and dog story is to us so is the crocodile story to the jungleman. He even goes further. He ascribes to the crocodile supernatural powers; he surrounds him with a halo of romance; he propitiates him with periodical offerings, and when diplomacy fails he declares war to the death—war lasting perhaps for years, till some trifling occurrence is construed into a sign of surrender on the part of the crocodile, and all is peace again.

Wonderful indeed and hard to believe are some of these native stories, but the majority of them are true for all that, though the fascination and glamor of them fades when the smooth musical Malay tongue is changed for matter-of-fact English, and the flickering glimmer of the *damar* torch on palm-leaf walls is replaced by the lamp and writing table of civilization. For these reasons I have confined myself to recounting a few of my own personal experiences in which I treat the crocodile figures not as the native reads him, but as I have found him—savage, crafty, and loathsome to the last degree.

But to begin at the beginning. My first experience of the "river king" was many years ago, when circumstances compelled me to travel for several hours in an extremely rickety and dilapidated dug-out along a tortuous and stagnant mangrove-lined creek. I had not been long in the tropics, and my great wish was to see—and if possible to shoot—my first crocodile. In the dug-out with me were my Chinese "boy" and the ancient owner of the craft—who by the way supplied the motive power with a paddle, while all my energies were directed toward keeping my balance and postponing the catastrophe of an upset, which each moment appeared more imminent. After an hour or so, when familiarity had bred contempt, and I was at length emboldened to stretch my cramped limbs and find a new and more comfortable position, I inquired of my venerable Charon whether there were any crocodiles in the creek. The old man, going as near to a chuckle as a Malay will allow himself to do, replied that I need not be afraid, that there *were* crocodiles, but that they were kindly beasts who never interfered with human beings. Feeling somewhat hurt at my inmost thoughts being thus probed, I relapsed into silence and a cheroot, and was momentarily growing more drowsy when a remark from the old native brought my thoughts back to earth with a start. "*Itu dia*, there's one," he quietly said, pointing with his mouth in the native fashion toward a tangle of mangrove roots and rotting vegetation, while his paddle rose and fell with unaltered speed. "There's one." I looked, I gazed, and peered among the mottled shadows, but nothing could I see that in any way resembled my idea of a crocodile. "Where?" I asked, and then it happened. My Chinese boy, ever anxious to please, had grabbed a piece of wood that was floating by, and hurled it violently at the spot indicated by the native. The next half minute was chaos. In my anxiety to see the crocodile I had raised myself up, and the lurch caused by the rash act of my servant in throwing the piece of wood made me lose my balance. I collapsed (luckily into the boat), some gallons of water came in over the side, and the old man at the stern, steadying the canoe with the quiet instinctive movement of one who knows his business, muttered the one word '*Bodoh!*' (Idiot). As I struggled once more to a sitting posture I saw a long black object, which I had taken to be a log, glide noiselessly into the creek, hardly raising a ripple as it vanished, and I caught a glimpse of two beady, cruel eyes which seemed to look greedily at me as they disappeared below the slimy water. I had seen my first crocodile, but whether the old man's last muttered comment was directed toward me or my servant I have never discovered, nor did I then feel inclined to ask. In either case it was richly deserved. This was many years ago, and though since that day some dozens of the loathsome reptiles have fallen to my rifle, I have never forgotten the look of malignant hatred and concentrated evil shot at me from those yellowish-green eyes.

From past to present is but a step for the memory, and it is only a few months since the incident happened that I am about to relate. My work took me on a visit up a river to one of those timber-cutting camps where are felled and rafted the great hardwood logs so valued in the Chinese market. G., the white man in charge, was a characteristic old "hard case," who had started life before the mast in a sailing ship and drifted in a beachcombing fashion to our colony, where he had been given, almost in charity, a subordinate billet in one of the large timber companies. Arriving in my boat at the little jetty or landing stage, I was astonished to find G. lying on a rattan couch within a few yards of the bank, with a heavy express rifle across his knees, gazing intently at a rough *pagar* or fence erected in the stream. Hanging from this fence and a few feet above the water were the corpses of a monkey and several pariah dogs, while half a dozen ducks, each tied to the fence by the leg with a long string, flapped about on the water and quacked dismally in their efforts to escape. I was just wondering whether the whisky bottle or too much solitude accounted for this state of affairs, when I noticed that G.'s leg was swathed in rough bandages from knee to ankle. Throwing myself down near him in the welcome shade, I learned the following story. Two nights before G. was sleeping peacefully in his little palm-leaf house in a clearing about twenty yards from the river bank, when his dog began to growl, and refused to be silenced. G. turned out and walked around the hut to ascertain the cause of the disturbance, but seeing nothing, addressed himself to the dog in his usual lurid and picturesque sailing-ship language and retired to bed again. Five minutes later he was once more aroused by a yelp from the dog, and this time, really annoyed, he seized a stick and sallied forth to inflict dire punishment on the disturber of his dreams. Suddenly a dark form glided swiftly from the shadows, and G. felt himself seized by the right knee as in a vise. Stooping to free himself, he found he was in the grip of a large crocodile, whose teeth were firmly embedded in flesh and bone. Backward and forward the struggle swayed, the crocodile striving to pull its destined victim to the water's edge, and G., hampered as he was by his imprisoned leg, fighting for his life to reach higher ground. At last the beast, hurling its victim to the ground with a shake of its powerful head, began to drag him swiftly toward the water. Poor G., feeling, as he expressed it, that it was all over bar the shoutin', determined to make one last effort for his life, and taking advantage of a momentary halt as the brute was steering past a tree stump, he sat up and succeeded in getting both his thumbs into the reptile's eye-sockets, the only vulnerable part of a crocodile's head. The rest of the story is perhaps best told in G.'s own words, or as nearly as circumstances (and the Editor) will permit. "So soon as I gets my thumbs made fast in 'is eyes, 'e opens 'is mouth to shout an' lets go my leg. Then first thing next mornin' the coolies 'ave 'is breakfast for 'im, as you see, an' I gets into this chair, an' 'ere I stays if it's a month." Vainly I tried to persuade G. to come away with me to the next station and see a doctor. I argued with him, I implored him, but it was absolutely useless. He refused to move from that chair till he had bagged his crocodile, and I was at last obliged to leave him, having dressed his leg and exhausted every known means of persuasion short of brute force. I met him again a week later lying in a hospital bed, suffering severely, but quite happy in the knowledge that the bones of that crocodile were bleaching in the sun outside his house. Poor old G.! Only a few weeks afterward the habit of clearing creepers from his path in the jungle with the butt end of his loaded and cocked rifle proved fatal to him.

Perhaps the most firmly engrained superstition in connection with the crocodile—if superstition it be—is the belief that the washing of a mosquito curtain in a river will be followed within a week by the death of some person in the village on its bank at the jaws of the crocodile. So implicitly is this believed that many villages take their curtains to some jungle pool or spring rather than even use water drawn from the river—this though the same persons will bathe and wash their garments actually in the river itself! The offender is usually some traveling Chinese trader, and curiously no less than four cases have come to my personal knowledge in which the washing of a mosquito-net in a river has within a week been followed by the taking of a villager by a crocodile. In one case nobody had been taken in the river for over a year, and in another case the wretched Chinaman was arrested by the zealous local policeman, himself a native of the district, and sent under custody to the nearest European magistrate, solemnly charged with causing death by a rash and negligent act, thereby committing an offense punishable under the penal code.

An account appeared some years ago in the local papers of Singapore relating how the native hunting dogs in that part of the world were so clever that, being desirous of crossing a river, they would first congregate on the bank and bark loudly to attract the crocodiles, and then run swiftly upstream and cross at another place. The tale was greeted with much editorial sarcasm, and commented on as something new in dog stories. A month or two after some incident recalled the story to my mind as I sat late one evening discussing the day's deer hunting with an old chief, who himself owned the premier pack of pariahs in the district. I repeated it as nearly as I could remember to the assembled village, who with one accord sat silent, waiting for the words of wisdom to fall from the old chief. For some minutes he chewed his quid of betel-nut in a meditating way, and then broke out with the following explanation, which I give in his own picturesque phraseology. "Wherever there is smoke one must seek the fire. This is a true story that has passed through many mouths. The way of it is this. It is not the cleverness of the dogs, but of the owners. The men of my people, when chasing a deer on foot with dogs, are always careful in crossing a river, for the yelping of the dogs calls together the crocodiles. The dogs therefore are trained to stop at the bank and bark loud and long. The hunters then cross at a place some distance away, calling their dogs, who follow in their masters' footsteps. That is truly how the story began, but it has altered in the telling, and is now like a child's fable."

The very next day I had an opportunity of confirming this explanation, for a deer put up by my own dogs during my evening stroll made straight for a stagnant backwater of the river and plunged in, closely followed by my three yelping terriers, who swam around and around him, snapping at his back and sides as opportunity offered. Some village dogs, attracted by the din, came rushing up and joined in the chorus, but without attempting to enter the water. Standing on the bank I was whistling vainly to my dogs when the deer gave an agonized scream and disappeared below the slimy surface of the pool, pulled down by some unseen foe never to reappear, though I waited for a good ten minutes. When I left there was not a bubble nor a ripple to show what had taken place. But no explanation was needed as far as I was concerned, and my three terriers following cowed and shivering at my heels had learnt a lesson that they remembered for a long time, though two of them eventually fell victims to a similar fate.

I have discussed the habits and customs of the *buaia* or crocodile with many natives, and their solemnly delivered opinions would certainly open the eyes of any naturalist. The majority are firmly convinced that the beast has the power of fascination similar to that generally accorded to the snake, and they also believe that the crocodiles in any given river will not molest man unless man has first molested them. When recently being paddled up a small river for the first time I was about to fire at a young crocodile lying on an exposed mud flat. "Don't, sir, don't!" cried the four paddlers as one man. I lowered my rifle and asked their objection. It appeared that in this particular river, though it swarmed with crocodiles, and the villagers habitually bathed there, nobody had ever been taken, while in the next river debouching at almost the same spot on the coast there was continuous and bloody strife between the natives and the crocodiles. This was corroborated by other villagers on the river, who ascribed their immunity to the fact that they had never killed a crocodile there, and in return the crocodiles had never done them any harm. Whether or not this can be accounted for on the theory that a crocodile "turns man-eater" like a tiger is an interesting problem.—Chambers's Journal.

To Paint Cement Work.—When air dry paint until white with a mixture of English sulphuric acid (not fuming) 1 part to 10 parts of water. Allow it to dry thoroughly and then paint with any oil or Japan paint.

MODERN FORTIFICATIONS.

THE PRINCIPLE OF THEIR CONSTRUCTION.

The history of fortification is as old as that of nations. New requirements born of the incessant improvement of artillery have modified its details, but its object remains the same as always: to allow the defender of a post to hold out against superior forces. For this purpose it is necessary to create an effective obstacle to the approach of the enemy, and also to provide shelters in which the defenders may be protected from the fire of the enemy while remaining free to use their own guns effectively.

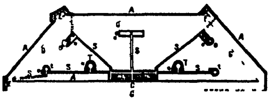

FIG. 1.—PLAN OF A MODERN FORT.

A [illegible]

Vauban introduced a wide and deep ditch between two thick walls, the escarpment on the inner side and the counterscarp on the side toward the enemy, and we find these elements repeated in all the old forts, including those which were built in the reconstruction of the French system of defense after the war of 1870. The forts surrounding Paris are classical examples of this construction.

II. New Principles of Fortification.—The newest forts present a totally different appearance. The ditch remains, but the huge earthworks of the old forts, 0 or more feet in height, have been abandoned as too vulnerable under the very accurate fire of modern artillery. In the most important French forts these great earthworks have been replaced by much lower but much thicker parapets, which are just high enough to give the defenders a good view of the surrounding country. The experience of the fort of Malmaison in 1886, following the introduction of highly charged torpedoes, proved that a thickness of at least 10 feet of earth is required to give certain protection against these terrible engines of destruction. Parapets of 4 or 0 feet in thickness are found in many of the newest forts. The ditch is constructed on a new plan. On the side toward the enemy a counterscarp about 1 feet high is retained, but this is now constructed of cement concrete and is at least [illegible] feet broad at the top. By this construction the joints of ordinary masonry are eliminated and the wall forms a homogeneous mass of remarkable strength. It is reinforced by a mass of broken stone 10 feet thick placed in front of it, which constitutes an obstacle to undermining by shells striking in front of the concrete wall and bursting underground. The escarpment on the inside of the ditch has entirely disappeared in its original form, at least. Now the bank is allowed to have its natural slope from the firing line to the bottom of the ditch, and a strong grill of barbed wire imbedded in concrete replaces the stone wall of the old type, which is too easily destroyed by persistent artillery fire. Finally, as the defender cannot see the bottom of the ditch from the top of the parapet, chambers of concrete with very thick walls, known as flanking coffers, are constructed at each end of the counterscarp. From these coffers the ditch can be raked by the fire of machine guns and other rapid fire guns, driving away any enemy rash enough and skillful enough to enter the ditch. At present, more than ever before, it is imperatively necessary to protect the defenders of the fort against bombardment, which now may be extremely effective. For this purpose shelters are constructed beneath the parapet, with concrete walls 8 feet thick, and in these shelters the troops detailed for service on the rampart take refuge during the entire fire of the enemy. The remainder of the garrison is sheltered in barracks, also built of concrete and furnished with all the indispensable conveniences of daily life. All of these rooms, including the flanking coffers, the shelters on the ramparts, the barracks, the casemates and the turrets described below, are connected together by a system of underground passages, through which the members of the garrison can circulate freely without being exposed to the fire of the enemy. Only a few sentinels keep watch on the ramparts from armored lookout towers, for the purpose of giving warning of the enemy's approach.

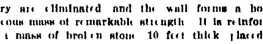

FIG. 2.—SECTION OF PARAPET AND DITCH OF A MODERN FORT.

A [illegible]

Gun Turrets.—The precision of modern gun fire makes useless all unprotected pieces of artillery, which would naturally be the chief points of attack by the enemy. Hence the large guns which were formerly placed in the forts are now collected in batteries behind the line of forts, and the latter contain only very small numbers of guns devised for special purposes. It is necessary for a fort to be able to constitute its own defense and to protect to the last moment the guns which command an important point. These guns might be mounted in casemates of concrete with walls 8 feet thick, which would afford effective protection against the enemy's fire. The openings through which the guns would be fired must in this case be made extremely narrow, in order to avoid making them particularly vulnerable, but guns protected in this way could be fired only in a very small number of directions. The adoption of the revolving armored turret is a much more satisfactory, although more costly solution of the problem. A gun turret consists essentially of a cylinder made of armor plates revolving in a well lined with concrete, which contains the necessary machinery and magazines in addition to the guns and the gunners. The concrete walls which line the shaft vary in thickness from 10 to 16 feet according to the type of turret, and are protected on the side toward the enemy by a mass of broken stone and an earthwork at least 0 feet thick. In order to obviate the possibility of a shell striking the edge of the well and detaching fragments of concrete which might fall between the wall and the turret and prevent the rotation of the latter, the mouth of the well is formed of a ring of hard cast iron, which affords additional protection and which furthermore provides a way of communication around the turret. At first a simple rotating turret was employed (Fig. 3). It consisted of an arched roof of hard cast iron 16 inches thick, supported by a frame of steel plates about 1½ inches thick. The roof alone appeared above the massive concrete wall of the well. Hence a turret carrying two 6-inch guns, offered a target only 3½ feet high and about 18 feet wide. The turret was turned by hand by means of gearing, the movement being facilitated by raising the whole mass by means of a hydraulic press acting upon the pivot of the turret, so that only 1/10 of the weight rested upon the wheels on which it turned, and the remainder was supported by the cylinder of the press.

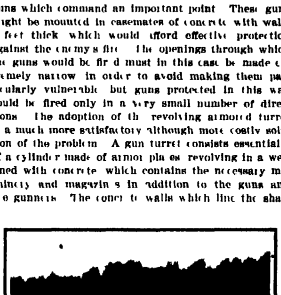

FIG. 3.—EARLIEST TYPE OF REVOLVING TURRET.

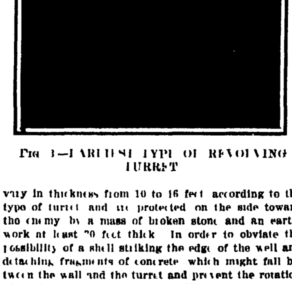

FIG. 4.—SECOND TYPE OF TURRET WITH GUNS PROTRUDING.

The increase in the use of armor and the continual improvement in artillery led to the construction of the second type of turret (Fig. 4), which is made of laminated iron and is much less visible. This was soon superseded by the disappearing turret (Figs. 5, 7 and 8), which is the only type now employed. In this turret the guns are retracted entirely within the armored portion. The portholes, which were very visible in the earlier turrets, are entirely covered, and they emerge from the concrete well only during the time required for firing.

FIG. 5.—TURRET IN DISAPPEARING POSITION.

The disappearing turret is constructed for one or two 6-inch guns, two 3-inch rapid fire guns, or two machine guns. The type, however, does not vary essentially. The moving mass is counterbalanced by weights, as in the turret already described, but the improvements introduced into this system of counterbalancing by Galopin have made the turret for two guns the remarkably effective weapon which is now installed in our forts. The shafts of the counterweights move on steel rollers, so that the length of the lever arm varies during the motion in such a manner that the turret reaches its final position with zero velocity. The turret being in its position of eclipse and offering only its low roof as a target to the enemy's fire, the guns are loaded and are aimed by the indirect method, by means of drawn plans. Meanwhile the counterweight has been wound up, and when all is ready, at the word of command, a catch is released and the turret rises. At the top of its course the two guns are discharged automatically by the closure of an electric circuit, and the turret immediately sinks. The time which elapses between the word of command and the complete disappearance of the turret is only five seconds, and two shots can be fired every 90 seconds.

The 3-inch gun turrets operate in a similar manner. The machine gun turrets are somewhat different. As they are much lighter, they can be moved directly by the gunners, and so easily that they can be caused to sweep the whole crest of the glacis during the volley.

The thickness of the walls varies with the type of turret. For the large calibers it is about 12 inches, a thickness which offers an effective defense against modern siege guns. In 1886 the Roumanian government, desirous of equipping its forts with armored turrets, made a very elaborate series of experiments with a French and a German turret. Neither turret was at all injured by either the explosive or the armor piercing projectiles of that day. Since that time the precision of fire has greatly increased, but the force of projectiles has undergone less change, so that it is probable that these turrets would still withstand a siege without serious damage. Experiments are now being made with an 11-inch mortar, throwing a shell weighing 550 pounds. The nearly vertical fire of these mortars would certainly be very dangerous for the roofs of disappearing turrets, but it should be remembered that in the Roumanian experiments 164 shells were discharged from a German rifled mortar of 8 inches caliber, at a distance of less than 3,000 yards, without making a single hit. The French disappearing turrets are constructed in accordance with the results of experiments made in 1887, 1905, and 1906. In regard to their strength, they inspire perfect confi-

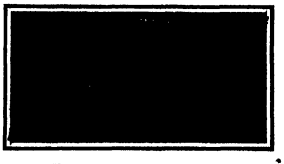

FIG. 6.—CONNING TOWER.

dence, and as their fire is very accurate, they constitute excellent weapons Unfortunately they are very costly, like all modern fortifications —La Nature

TO MAKE PLASTITE MASS

The mass so designated has a deep black color and sufficient hardness to admit of being sawed planed turned, and also highly polished Owing to these properties of plastite, many articles usually made of horn metal or hard stone can be easily prepared from this material

There are many recipes for compounding plastite mass As a rule in addition to the ingredients which go to make up the actual plastite indifferent substances, most commonly magnesia are used on account of their light weight as a filling These serve only to increase the volume of the mass and have no essential effect on their composition

Plastite mass possessing in complete measure the excellent qualities mentioned above is compounded as follows

Caoutchouc (India rubber)	100	100
Sulphur	20	25
Magnesia	40	50
Golden sulphur of antimony	40	50
Coaltar pitch	50	60

These substances are mixed till they form a thoroughly uniform mass which is first warmed to make it more plastic then forced by means of vigorous pressure into iron forms and vulcanized in the ordinary manner like rubber According to the intensity of the heat applied the articles turned out are either elastic almost as much so as rubber vulcanized in the usual way—or hard as ebony

By using a highly plastic artificial asphalt masses may be prepared in this manner differing very little in regard to elasticity from vulcanized rubber though containg comparatively little of the latter substance

Such masses displaying approximately the properties of genuine whalebone with respect to their elasticity are also described as artificial whalebone or balenite Made into thin sticks they are used in the same way as genuine whalebone

THE WONDERS OF FORMER AND PRESENT PHYSICAL MEASUREMENT

The degree of exactness attained by scientific methods of measurement and weighing is known to comparatively few persons and must provoke boundless amazement in the general reader A recent number of Die Deutsche Revue publishes a digest of a lecture delivered in Amsterdam by Prof Woldemar Voight of Goettingen on the stupendous progress made in the methods of physical measurement The title of the lecture was The Struggle for the Decimal in Physics Says the Revue What degree of exactness is attainable in physical measurement? That is the question At the present day a thoroughly skillful cabinet maker can put out work of which the dimensions are true to a per cent that evokes enthusiastic praise To physicists such a degree of exactness signifies really nothing and they are constantly striving to attain a further decimal for all constants Voigt selects as an example the determination of the degree of the force of gravity or what amounts to the same thing the determination of the length of a pendulum for seconds In his experiments with gravitation at the leaning tower of Pisa Galileo observed that the duration of the fall of an object dropped from the top of the tower was three and a half seconds In this the initial and the final moment of the fall can be determined to the fifth of a second approximately that is the exactness of the statement of time may depend on an eighth

For the solution of this problem the Dutchman Huyghens used a pendulum that at once brought exactness to a thousandth not because the initial and the final moment of the oscillation of the pendulum was determined but because the number of oscillations was measured So it was believed that correct figures were now determinable Then the remarkable discovery was made that the length of the pendulum was not equal under different latitudes and so a source of error in measurement was found Soon another was found, as a method of determination there was hung before a clock a thread pendulum that was regulated until it struck the second in this the investigator had to keep in view that one pendulum influences the other and thus exactness could again be enlarged as a result of the investigation conducted by the Paris Academy in 1730 in this direction the astronomer Mairan discovered a new source of error the stiffness of the thread of the pendulum while he kept in view that the pendulum used was not a mathematical but a compound one Certain theoretical considerations thus evoked again improved the statements Borda, too, found many sources of error all of which were taken into account. * * * for instance the influence of temperature, the extension of the thread of the pendulum through centrifugal force during the oscillation, and the swelling of the pendulum in consequence of the surrounding air, Still more important progress was made by Bessel whose calculations regarded also the quantity of air carried along by the ball of the pendulum He determined finally for the length of the pendulum for seconds under a given latitude a value of which the exactness was calculated to one five hundred thousandth

Many a one who is the possessor of a letter scale firmly believes that this instrument is a model of exactness But chemistry works with scales that indicate with certainty the fiftieth part of a milligramme A chronometer is a beautiful thing indeed and the owner of it has the manifest right to be proud of this little masterpiece of technic But what can its accuracy to a second signify as an indicator for the sharp observation of a Foucault the famous natural philosopher who has measured the time that light takes to go a distance of twenty meters and has determined it as the sixteen millionth part of a second? For measurement of the length of the waves of light use is made of the so called trellises and that is strips of silver every millimeter of the length of which is marked with one thousand lines and can therefore indicate the millionth part of a millimeter A pendulum constructed for the measurement of angles has indicated a movement of the three hundredth part of an angle second To grasp approximately the smallness of such an angle one needs only to imagine rays proceeding from his eyes and striking at a distance of sixteen hundred kilometers the edges of a thin disc having a diameter of one inch say Spectrum analysis for instance, can indicate marvelously small quantities say even the three millionth part of a milligram of natron which when such a small fraction is burned, still betrays itself through a distinct yellow line in the spectrum."

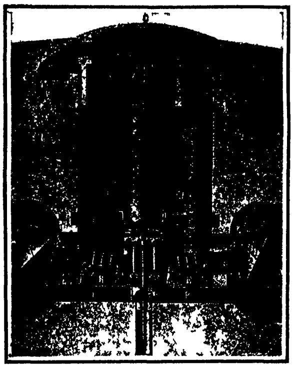

FIG 7—SECTION OF GALOPIN DISAPPEARING TURRET

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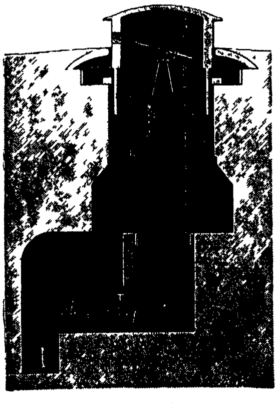

FIG 8—SECTION OF 3 INCH DISAPPEARING TURRET IN FIRING POSITION

PROTOPLASM IN HARNESS

Galls on plants in at least the more conspicuous forms must have been known to man from a very early period in his history and the presence in them of living animals might have been expected to suggest inquiries as to their source and relation to plants yet even after Malpighi had published the results of his study of various galls and had been followed by Reaumur in his admirable Memoires the interest in those curious growths long remained limited to a very few To botanists they were little more than excrescences on or defects of plants lessening their value as specimens while zoologists were rarely attracted to the study of the makers which belonged for the most part to mites nematode worms midges and other groups difficult to study and little attractive in themselves

But the latter half of the nineteenth century was marked by an almost sudden outburst of activity about 1870 led by Drs F Thomas D von Schlechtendal F Low G Mayr and others resulting in numerous papers filled with descriptions of previously unknown galls and gall makers and with life histories disclosing new relations between plants and animals as well as new cycles of development of the animals Such discoveries as the surprising dimorphism so general among the Cynipidæ that gall the oaks attracted keen interest which showed itself in an increase of workers and in a more and more rapid advance in the study of galls especially in faunistic researches and in more accurate determinations of the gall makers and the influence on one another of the host and the parasite

The diversities in structure among galls (the alterations induced by the gall producers in some cases amounting only to slight enlargement of the parts involved while in others they result in bodies of complex nature and definite specific forms) and the systematic relations among the numerous gall bearing plants and also among the gall producers support the belief that the power to affect the protoplasm so as to lead it to produce structures useful to the gall makers has been acquired independently by numerous organisms (plants as well as animals) in widely different grades of development If that is so it seems reasonable to expect that power to control the activity of protoplasm will at least to some extent be acquired by man and may produce results of great value Although as yet experiments have thrown little light on the artificial production of galls there is a very attractive field open for research in this direction

Since 1870 an extensive literature has appeared dealing with galls dispersed so widely that much of it was almost beyond reach of even keen students in this field In 18 8 G von Halmhoffen estimated the known galls of Europe at from 300 to 350 In Kaltenbach's Pflanzenfeinde issued in 1873 and 1874 the galls of central Europe formed by insects and by a few mites were described under the host plants and from 1890 to 1895 D von Schlechtendal issued a catalogue of the galls of animal origin then known to occur in Germany

In 1901 appeared two works giving brief descriptions of the galls of Europe and of the Mediterranean area Kieffer's Synopsis des Zoocécidies d'Europe and Darboux and Houard's Catalogue systématique des Zoocécidies de l'Europe et du Bassin Méditerranéen These were most welcome and stimulated research so greatly that a new catalogue had already become necessary when M Houard supplied the need by his latest work Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditerranée Based upon the Catalogue and covering the same area comparison of the two shows remarkable progress during the few years that elapsed between their dates of issue Such a comparison is a little hindered by the host plants being arranged in the earlier list in alphabetical order of the generic and specific names while in the later they are in families these following the order in Engler's Pflanzenfamilien while within each family the genera and species are grouped after Nyman's Conspectus Floræ Europeæ The advantages derived from the rearrangement of the host plants beside their allies far outweigh those of the alphabetical arrangement

The comparison between the individual hosts in the two lists shows very careful revision of the descriptions common to both the omission from the second of some forms included in the first the definite reference to their makers of numerous galls previously of unknown or doubtful origin and the addition of many recently discovered galls some on plants already known to bear galls others on new hosts A rough indication of the advance is given in the rise of the marginal numbers attached to the galls from 1 69 to 6 239 but perhaps a truer value is afforded by the increase of the host plants in much the same proportion and of the known gall makers from 1 0 2 to 1 3 species the increase being especially large among the Curculionidæ (beetles) the Cynipidæ (gall flies) the Cecidomyidæ (gall midges) and Eriophyidæ (gall mites) —Nature

TECHNOLOGICAL CHEMISTRY.

ITS DEVELOPMENT DURING THE LAST FORTY YEARS.

BY PROF O. N. WITT.

The representatives of chemistry, general and physical, inorganic and organic, have striven in noble emulation to surpass each other in the number and importance of their discoveries. From the laboratories, great and small, official and private, the results of research have flowed like the rivulets which, irrigating the well-watered fields, come together in brooks, then in streams and in rivers, bringing fertility to the habitations of men in the valleys. An abundant harvest has been raised on these watered plains, a harvest which has been enthusiastically consumed by the people.

The harvest, the reward of scientific research, the abundant fruit of the patient work of the mind, consists of the applications which contribute to the well-being of the people. This is why technical chemistry is the worthy companion of abstract research in our science. It should prosper when research is flourishing, and the additions to chemical technique during the last forty years are a striking proof of the correctness of this assertion.

About the time when the German Chemical Society was founded a period of far-reaching transformation began in industrial chemistry. The industry of mineral acids and alkalis based on the Leblanc process, the only one which could boast at that time of the title "great chemical industry," still adhered to its stereotyped operations and to the dependency of its series of steps one upon the other, but the young Titan which was destined to struggle with and cause its complete rehabilitation—the Solvay process for the production of soda by means of ammonia—had come into existence and was already developing. About 1870 this process appeared to have reached a productive stage, and it was recognized that the possibility of obtaining soda independently of the Leblanc process would break up the whole continuity of this great chemical industry. It was still protected, however, by the close dependence on it of the production of hydrochloric acid and from this the making of chlorine by the sulphate process, and by the advantages offered by the soluble product of its raw soda in the preparation of caustic soda. In truth these two circumstances prolonged the life of the Leblanc process for several decades and are responsible for the fact that even yet it has not entirely disappeared.

Toward 1880, almost simultaneously with the development of a commercial process for the production of soda by ammonia, came the inauguration of the potash industry at Stassfurt, which was founded on the fortunate discovery of the deposits of salts there under the fertile influence of Liebig's wonderful researches.

To the preparation of potassium chloride from carnallite and sylvinite soon was added the preparation of bromine, of potassium nitrate by the use of sodium nitrate, and the manufacture of potash by the Leblanc process without any danger here of a concurrent process with ammonia. Finally a successful process was developed for the utilization of part at least of the magnesium compounds which were present in the salt deposits, although the successful extraction of all the magnesium chloride made in the potassium industry is to-day still in the category of unsolved problems.

The year 1870 saw the rejuvenation of the century-old industry of oil of vitriol. The fuming sulphuric acid, whose small content of sulphuric anhydride no longer sufficed for modern needs.

In place of the product obtained by distilling vitriolic schists came synthetic sulphuric anhydride, prepared by the catalytic combination of sulphurous anhydride and oxygen, and the pyrosulphuric acids. The new process of manufacture was to influence and transform the whole sulphuric acid industry to a great extent. It was possible to apply it with advantage more than a quarter of a century later, when the modern process appeared.

The last two decades of the nineteenth century were characterized by the development and application with exceptional rapidity of electro-technics. In the field of chemistry this new phase of industry showed itself in the development of electrolytic methods of separation. In the field of electrometallurgical processes, the most important of which are the preparation of aluminium and the electrolytic refining of copper, which are closely followed by the manufacture of calcium carbide and carborundum, the question of the electrolytic decomposition of alkaline chlorides has been a most warmly discussed problem. The difficult problem of preparing membranes which are more sensitive and at the same time more resistant was solved almost simultaneously by three processes, that of Griesheim, that of Castner-Kellner, and that of Aussig, which are close rivals in their effectiveness and boldness of invention. With these a new era has begun in the production of caustic alkalis and also in the chlorine industry. The old process for the production of chlorine has disappeared along with the ingenious methods of Weldon and Deacon. Chlorine, once so costly, is produced in such abundance as to provoke a feverish search for new applications for it. By the side of and often in the place of the venerable chloride of lime we find to-day liquefied molecular chlorine put up in transportable form in steel bottles.

Finally the production of alkali metals on a large scale should be counted as one of the most important results of modern electro-chemical technology. The same reaction in a form suitable to technical methods which once in Davy's hands led to the discovery of these metals, the electrolysis of alkaline hydrates—has shown itself to be the best and least costly method of manufacture for these strongly reactive bodies, one of which, especially sodium, has rapidly become of extensive application in a technical way. By its aid in particular it has been possible to produce potassium cyanide free from cyanates, which has contributed to the success of the cyanide process for refractory gold ores.

Such a metamorphosis of inorganic chemical technology as has been briefly described would not have been conceivable if greater and greater quantities with their continually decreasing prices had not found a continually increasing market. The same fact, along with the natural increase of needs generally, has produced in the case of organic chemistry an even more striking and remarkable transformation and development than in inorganic technical processes.

We all know in a general way that the old industries of brewing, distilling, sugar making and starch making, of the production of fatty bodies and of foods, all of which are connected with agricultural work, have flourished remarkably in the last forty years and have become of very great importance. They owe their most important progress to the aid of modern biological research. But besides these other industries operating on organic substances have sprung up and prospered which were formerly entirely unknown.

A lively interest attaches to the chemical application of wood, which has not only allowed a particularly profitable use of our forests, which is coming more and more into evidence, but has also led to a simple separation, almost analytical in its nature and carried out on a large scale, of the components of lignine, one of which, however, the incrusting medium, remains to this day a chemical enigma.

The extraction of an almost pure cellulose from wood has placed the paper industry on a new footing and has obviated the necessity of our limiting the production of printed matter for want of paper. It has led to the discovery of a number of other useful applications of cellulose, of which I will mention only the preparation by various methods of new artificial textile fibers analogous to silk.

Wood can be worked chemically, however, in another way than by the separation of its content of cellulose. I refer to the process of dry distillation. The very primitive preparation of carbon and wood tar of the old days has developed during the last forty years into a very highly perfected art of wood distillation, which has obtained most important commercial results with decomposition products formerly entirely neglected—methyl alcohol, acetone and acetic acid. The attempts, first without result but later crowned with success, to free the ligneous acetic acid from the empyreumatic bodies obtained with it have resulted in the fact that the greater parts of our demands for acetic acid are now supplied by the distillation of wood. This industry received a still further impetus in 1890 by the introduction of a process for the preparation from methyl alcohol of formaldehyde, the production of which has enormously extended since the extraordinary variety of uses to which this new product can be put has been recognized.

Another remarkable method for the treatment of wood, fusing it with alkali for the production of oxalic acid, has not developed, but rather has diminished in importance during the forty years under consideration. It has been replaced by the synthetic method of preparing this acid as well as of formic acid by means of carbon monoxide contained in generator gases. Formic acid can be prepared so advantageously in this way that it is competing with acetic acid in many of its applications.

The commercial utilization of hydrocarbons of the methane series is brought out in two industries—the distillation of lignites and the refining of petroleum. Both of these industries have shown an extraordinary increase in their extent and have displayed numerous marked improvements in their production. Among these last the desulphurization of fetid petroleum of the Ohio type by distillation over copper oxide should be considered a technical achievement of high rank.

The development of coal distillation and the treatment of tar affords a particularly important and interesting example of progress. When this society was founded only one form of distillation of coal was recognized—its application to the manufacture of illuminating gas, which dates from the end of the eighteenth century. This distillation was carried on at a low temperature and furnished the entire amount of tar produced, the tar which is so important in the recently developed color industry. In 1880 the output of tar began to be less abundant, a fact caused not only by the constant increase in its use in the production of tar dyes, but also to a great extent by the far-reaching transformation of the gas industry, which on account of extended and ingeniously interpreted experiments had been developed into an entirely new process characterized by the employment of high temperatures of distillation. The momentary embarrassment which fell on the dye industry led to the creation, far-reaching in its consequences, of a new industry, distillation for coke, which saves from destruction the riches contained in the by-products of coke manufacture and which frees for a long time the dye industry from any lack of raw materials.

Among the products derived from coal tar may be mentioned anthracene, carbazol, the xylenes and the cresols, coumarone and pyridine substances, whose systematic manufacture is only forty years old and which have found a steady commercial application. Of many of the other of the tar derivatives some have been only recently discovered, while others have been rendered more available than heretofore.

It is to the improvement in its methods of operation, especially in the apparatus, that the industry of tar distillation owes the thoroughness with which its products may be separated from such a complex mixture as goes to make up tar. Column stills, filter presses and processes such as vacuum distillation are the means which have enabled the modern tar industry to attain its present position.

The most striking example of an industry working hand in hand with scientific research, profitably applying all its results and influencing them in its turn, is afforded by the manufacture of coal-tar colors. It is almost impossible to touch in these few words on the most important stages of the triumphal progress of this industry.

We may say that the foundation of the German Chemical Society was coincident with the date when the newly founded color industry was emancipated from empirical methods and turned toward scientific synthesis. The first great success obtained through this agency was the creation of the alizarin industry, whose later development has surpassed all expectations. The recognition of the close connection between constitution and properties of coloring matters found its practical application in the introduction of azo dyes, which not only brought into the industry an extraordinary variety of colors, but accustomed the dye chemist to develop almost quantitative methods of work. In the group of phthaleins were found not only some of the most striking coloring materials but also some of the most permanent, thus refuting the theory, not proved but then current, that artificial colors were ephemeral in the same proportion that they were brilliant. Equally permanent dyes were found among the eurhodines, safranines, oxazines, indulines and thionines, the study of which is so intimately bound up in that of nitrogen chains and the joining of nuclei. The discovery by a mere chance of a fast alizarin blue, so important from a technical point of view, likewise carried in its wake great consequences for scientific chemistry, for the investigation of the composition of this dye led to a synthesis capable of general application of the derivatives of quinoline. In a like manner the explanation of the constitution of rosaniline was very productive in allowing the synthesis of numerous

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* Address before the German Chemical Society at the celebration of the fortieth anniversary of the society, November 11th, 1907. Translated for Smithsonian Institution annual report from Berichte der deutschen chemischen Gesellschaft, Jahrgang XXXX, Heft 17.

new compounds, among which are found some of the most beautiful and valuable dyeing materials.

The appearance of substantive azo colors, and finally of those known as sulphonated dyes, has not occasioned the opening of any new avenues of scientific investigation. These two accomplishments, however, are of the greatest importance in that they have provided new methods for dyeing and printing and have completely revolutionized these two ancient industries.

Lastly we may mention the new class of indanthrene colors, in which are united clear tints with an hitherto unknown resistance to all destructive influences.

It is the synthesis of indigo, however, that we must hail as the most brilliant of all conquests in the field of coloring materials. We can still recall the day when the great event in chemical history was made public and when every hand was extended in congratulation for this masterpiece of scientific research. The struggle for a solution of this great problem cost twenty years of assiduous labor, but once solved, how well the new product of synthetic indigo has stood the test beside the natural product backed by several thousand years' use!

There is no hope that this industrial triumph in the coloring field will ever be surpassed. It is none the less certain, however, that this industry has not yet attained the limit of its development. Our reviews in the future will still record many achievements bearing witness to the uninterrupted development of this interesting and manifold branch of technology.

We may consider the manufacture of synthetic medical preparations as an offshoot of the color industry which sprang up in the period we are considering and which has already earned a position of its own. What brilliant results have been accomplished in this field also! What a beautiful gradation of development from complex insufficiency to simple perfection can be witnessed in comparing kairine and thalline on one side and antipyrine, phenacetine and aspirine on the other! What a progress in the regulation of physiological functions is evidenced in chloral hydrate and veronal! What pains has not synthetic chemistry soothed by its activity in this field, what ills has not it assuaged!

The industry of artificial medicines is only one of a vast circle of varied activities which we are in the habit of grouping together under the collective term of preparation industries. To properly appreciate this industry with all its ramifications is impossible. Nevertheless I cannot help mentioning the appreciable growth of a branch of this industry which is almost as old as this society. This is the manufacture of chemical products and preparations for photography, whose expansion has been closely connected with the development of scientific photochemistry and with the introduction and popularization of dry photographic plates with their proper processes of development.

No less interesting are the chemical and technical aspects of the perfumes newly created and developed during the last forty years. This field, which is completely developed along its principal lines at the present day, was still unexplored at the time when the German Chemical Society was founded. Its expansion is reflected more completely in the pages of our transactions than anywhere else. Step by step nature has been imitated in its creations, and in this field perhaps more than anywhere else the synthetic chemist has taken paths which follow those of nature.

Among the synthetic industries we should count the technology of explosives, although here it is a matter less of constructing molecules than of storing up energy in a form easily liberated. In this industry great progress has been recorded, almost all of which depends on the utilization of the facts expressed by the law of Sprengel, expounded about forty years ago, and on the employment more and more of safe explosives which can be detonated only by an initial ignition in place of bodies themselves explosive. The possession of such explosives and the application to the phenomena of explosion of modern methods of observation have alone made possible the new orientation in ballistics which is well known to all of us.

If we consider all this technological progress that I have mentioned and much more which I must refrain from describing, we must agree that as far as applications are considered our science has reached a high state of development. But just as scientific research, in spite of the abundance of results, still presses forward, so will technology not stand still, but will continue to attack more and more difficult problems.

When this society was founded there was already, it is true, a very well developed series of chemical industries, but their activities were limited almost entirely to the extraction, purification and transformation of natural products. An industry operating synthetically on a large scale is a development solely of the last forty years. To-day we are striving for even more lofty ends. We have dared to lay a hardy hand even on the great processes of nature in seeking to influence them according to our needs. It is this that we behold in the great factories where many are striving to utilize the nitrogen of the air. Many methods have been proposed to attain this end; the combustion of nitrogen to its oxides and the transformation of it into cyanogen or ammoniacal compounds have been used.

All these methods are practicable and will all probably be productive of results. Which of these results will be the most important it is for the future to decide. In all of them, however, is this characteristic feature—they do not rob Nature of its amassed treasures, nor do they wish to imitate her creations; they aim merely to assist her in one of her greatest processes, the circulation of nitrogen. If we succeed in influencing this phenomenon we will also in a measure control that other which is so intimately bound up with our fortune or misfortune, the course of life. We will force the earth to greater fertility, to an increasing habitability.

In such a task Nature herself should be our ally. The savage force of the water which falls from above carries out the chemical work which we call upon it to perform, and a day is beginning to dawn when it will be not only a pretty metaphor but one of peculiar force and meaning to speak of the fertile influence of the brooks which ripple down from the mountains into the valleys where stand the habitations of men.

LIQUID AIR AND OXYGEN.

SOME NEW USES.

Some interesting industrial applications of liquid air and of oxygen made from liquid air were noticed in a recent paper read by Mr. George Claude before the Society of Civil Engineers of France.

Commercial plants for the production of liquid air by the Claude process or by the Linde process exist in various European countries (there is also quite a large one in this country using the Linde process in Buffalo, N. Y.). Their chief product is compressed oxygen, and the principal applications of the oxygen are autogenous welding with the oxy-acetylene flame, cutting of metals with the oxy oxy-acetylene flame, and the manufacture of artificial precious stones.

But the price of oxygen thus produced is still comparatively high, as Mr. Claude points out, on account of the large expense for compressing and bottling the oxygen gas in cylinders and the shipping expenses. The cost of the oxygen gas would be greatly reduced if it were required *in large quantities on the spot*. An essential item in the cost is represented by the pressure to which the air under treatment must be compressed. This pressure is given by Claude as 18 atmospheres for apparatus producing 100 cubic meters (3 530 cubic feet) of oxygen per hour, and is estimated as 10 atmospheres for 1 000 cubic meters (35 300 cubic feet).

At present 1 cubic meter (3 3 cubic feet) of oxygen is obtained per horse-power hour in apparatus producing 50 cubic meters (1 765 cubic feet) per hour. The figure of 1.25 cubic meters (44 cubic feet) of oxygen per horse-power hour is guaranteed by the Société de l'Air Liquide for apparatus producing 200 cubic meters (7 060 cubic feet) per hour, and the figure of 1.75 cubic meters (62 cubic feet) of oxygen per horse-power-hour represents *the hopes of the manufacturers* for apparatus producing 1 000 cubic meters (35 300 cubic feet) per hour.

A plant for the yearly production of 50 000 000 cubic meters (1 765 700 000 cubic feet) of pure oxygen requires not more than 20 meters by 30 meters (65 feet by 98 feet) floor space and 15 attendants.

For a plant to be erected with apparatus producing 200 cubic meters *(7 060 cubic feet) of oxygen* per hour Mr. Claude's company has guaranteed that the cost of producing 1 cubic meter (35.3 cubic feet) of oxygen, including amortization, will be slightly more than 0.6 cent; that is, figured on the basis of the cost of 0.4 cent per horse-power-hour (an exceedingly low price which is thought to be justified because blast furnace gases are used in driving the gas engines for power production at that place).

A very important and interesting experiment on a large scale is soon to be made by a Belgian iron and steel plant, the Société d'Ougrée Marihaye, with respect to the enrichment of the air with oxygen for the blast in one of their blast furnaces and converters.

At the conclusion of his lecture Mr. Claude showed a number of experiments, like the liquefaction of oxygen in contact with liquid nitrogen, the condensation of atmospheric air on the outside of an iron bottle containing liquid nitrogen, further the fact that coke maintained at the temperature of liquid air absorbs gases with such energy that it is possible to realize rapidly a vacuum of less than one ten-thousandth of a millimeter. Mr. Claude also subjected a current of illuminating gas fed to a burner to the action of liquid air; the result was a modification of the flame, which assumed the characteristic appearance of the hydrogen flame. This experiment indicates the possibility of a cheap process for making hydrogen by partial liquefaction of water gas. Other experiments illustrated the case of recovery of volatile substances in chemical industries by refrigeration, such as ether and alcohol in the manufacture of artificial silk, and the facility of extracting neon and helium from the atmosphere.

In this connection it is interesting to report a lecture delivered November 18th, 1909, before the Polytechnic Association of Berlin by Dr. H. Erdmann on the technical application of liquid oxygen. (Chemiker Zeitung.)

Dr. Erdmann first discussed briefly the chemical properties of the liquid gas and also described a modified arrangement for investigation of its purity by means of the aerometer. It is possible to utilize liquid oxygen at the same time for three purposes, namely, to utilize its cooling effect, the pressure and its chemical energy.

The consumption of liquid oxygen is much greater than is generally supposed, although we have no accurate statistics regarding it. Three methods of manufacture are in use. By the Brin method barium oxide (BaO) is heated in a current of atmospheric air to form barium peroxide (BaO_2). The air current is then stopped and the barium peroxide reheated in a partial vacuum, whereby oxygen is given off. By the second, the electrolytic method, the gas is obtained from water, but this is economical only when there is use at the same time for the hydrogen generated simultaneously with the oxygen in equivalent proportion. Electrolytic cells for this purpose have been devised by Schuckert, Garuti, Schmidt, and others. The third method, based on the fractional distillation of liquid air, is now very largely employed in Europe. For operation on a large scale the cascade principle, which was first used by Pictet in 1877, is used to advantage. The lecturer mentioned briefly the processes of Cailletet, Kamerlingh Onnes, Claude, Hildebrand and Linde.

Altogether there is annually produced in Germany 8 000 cubic meters (282 00 cubic feet) of oxygen (meaning evidently oxygen gas at atmospheric pressure) by the Brin method, 342 000 cubic meters (12 070 000 cubic feet) by the electrolytic method, and 2 200 000 cubic meters (77 700 000 cubic feet) by the fractional distillation of liquid air. The average cost for one kilogramme of fluid oxygen amounts to about 1[illegible] pfennigs.

The oldest use found for oxygen is in explosives, oxygen cartridges not being dangerous. In recent years oxygen has found use in the production of light. In this connection was mentioned the Nurnberg light, which it has been found consumes very little illuminating gas and produces less heat than the ordinary gas lamp. It is also more hygienic, since the oxygen is supplied to the flame and is not therefore taken from the air, thus contaminating the latter. In metallurgy oxygen finds many uses, for instance, in the oxy-hydrogen and oxy-acetylene flame for autogenous welding and cutting of metals. Oxygen is also used in the production of fused quartz (silica) vessels. Oxygen used in medicine must have the highest purity; this accounts for the high price. According to Michaelis oxygen which is 96 to 97 per cent pure costs 6 marks ($1.43) per cubic meter, while 99 per cent oxygen costs 10 marks ($2.38).—Metallurgical and Chemical Engineering.

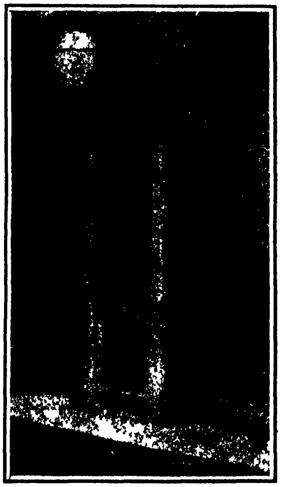
The Baku papers state that the exploitation of the well water—i. e., the water that accompanies the naphtha in the bore holes, which consists of a concentrated salt brine—is about to be commenced. It contains iodine and bromine, both of which can be extracted and the remaining liquor evaporated for salt. Attention is also called to the water in the Grosny wells, particularly in the Daghestan district, where during the boring highly concentrated brine was found—with the naphtha—rich in iodine. The idea of treating these waters is not of course new. Mr. K. I. Lisenko long ago called attention to the rich content of salt and iodine they held and which were run into the sea from the Baku wells. But for want of means they had to be let go on.

THE URANIA-ZÜRICH EQUATORIAL TELESCOPE.

AN ELECTRICALLY CONTROLLED INSTRUMENT.

BY FRANK C. PERKINS.

EQUIPMENT FOR WINDING UP THE WEIGHT



THE ELECTRIC SECOND CONTROL

THE URANIA-ZÜRICH EQUATORIAL TELESCOPE.

A most interesting equatorial telescope is in operation at the Urania-Zurich Observatory in Switzerland, a telescope which is of unusual interest because it is electrically controlled. It is seen in our illustration mounted for tests on a brick foundation.

The intricate eyepiece and controlling wheel of this new equatorial telescope and the construction of the electric automatic weight elevator and the astatic friction spring governor with the electric second control utilized on this instrument are also illustrated.

There is not only an electrically operated equatorial telescope system for the hour wheel, but also for declination. It may be stated that the introduction of photography as an indispensable auxiliary to the refractor and its simultaneous employment for visual observations of different kinds, as well as for differential measurements and the spectroscopic observations, make it necessary to construct instruments with still greater light gathering power than heretofore and as a consequence larger dimensions are necessary, imposing special conditions on the construction of the telescope mountings.

The telescope mounting must have its movable parts divided into two equatorial systems for holding the instrument upon the object observed. There must be complete avoidance of all flexion of the hour and declination axis with ease of movability about the latter, entirely relieving it from strain by means of a special supporting system. There must be such a mounting of the telescope that relative changes of place of the ocular end of the instrument are reduced to a minimum and the mounted auxiliary apparatus, such as astrophotographic cameras, must be within easy reach of the observer at the ocular end.

It may be stated that the Urania-Zurich instrument has an aperture opening of 300 millimeters (12 inches) and a focal length of 5 meters (16.4 feet). The telescope is driven by clockwork and needs no supervision during observation.

One of the accompanying illustrations shows the equipment for automatically winding up the weight and driving the clock train by electric power. Another illustration shows the friction spring governor and electric second control for regulating the drive.

The electric automatic weight elevator is of interesting construction. The weight is suspended by a Galle endless chain and is continuously wound up by the electromotor. A resistance regulates the irregularities in the speed of the motor and the vertical displacement due to them. When these displacements attain a certain position the automatic commutator sets the electric motor in action or cuts it out. When the observations are ready to begin the motor is placed in circuit by means of a switch, and the winding mechanism is connected with the governor by means of the transmitting shaft.

It may be mentioned that the friction spring governor is astatic, that is to say, once the velocity of revolution is adjusted it remains constant by the amplitude of the balls, the centrifugal force being proportional to the distance of the balls from the axis of rotation. This force is always balanced by the tension of a spring suitably connected with the governor arms, and by modifying this tension the angular velocity can be regulated between certain limits, the governor regulates the mechanism by means of centrifugal force accompanied by the increased amplitude of the balls.

An electric second control is provided in addition to the governor, consisting of a friction coupling and an electro-magnetic circuit breaker. The control is brought into action by a pendulum beating the seconds by means of a conducting wire. When an ordinary electric light current is used from a central station it is necessary to insert a resistance such as an incandescent lamp into the circuit as indicated.

It will be noted that the connecting rod transmits the governor motion to the driving of the hour wheel, there being two driving worm wheels engaging the hour wheel at two diametrically opposite points. These are coupled together by a shaft in such a manner that each of the two worm wheels transmits an equal force to the hour wheel. In consequence the hour axis is not loaded by the turning forces and errors of driving in the hour wheel, if such exist, do not affect the hour motion of the instrument by more than a fraction of their value.

It is of interest to note that the slow motion of the telescope is operated in both coordinates by means of rods from the ocular end. These rods are provided with toothed wheel gearing permitting the speed of the two motions to be rapidly changed from ocular end.

In accordance with the factory and workshop act of Great Britain the British government has issued regulations relating to safety arrangements to be used in dry grinding and finishing processes. According to these rules all grinding wheels must be provided with a hood or other appliance so constructed and arranged as to take care of practically all dust created. A duct of adequate size arranged to carry away the dust must be provided, and a fan or other effective means for extracting the dust must be installed. Suitable respirators must also be provided for all persons employed in grinding, whether working in a room or in the open air. No person is permitted to do any work other than grinding in a room where grinding is carried on, except work required for cleaning purposes. Provisions are also made for effective cleaning of rooms in which grinding is carried on at least once a week. The employer is required to furnish all safety apparatus, respirators, etc., and every person employed is required to make full and proper use of the appliances provided.—Machinery.

SCIENTIFIC ACCELERATION AND BRAKING

Dr. H. S. Hele Shaw, president of the Incorporated Institution of Automobile Engineers, took the chair at the fourth meeting of the session of that body in the Institute of Mechanical Engineers, Westminster, when Mr. F. W. Lanchester lectured on "Tractive Effort and Acceleration of Automobile Vehicles on Land, Air and Water." He dealt with some of the more generally neglected aspects of the subject, and endeavored to demonstrate the method employed by him for the measurement and recording of acceleration and tractive effort. He argued for the expression of all quantities under one kind of unit as against the rather general method whereby the tractive effort and resistance are commonly given in terms of pounds per ton of gross load, and quite frequently they are measured positive in opposite sense. Thus the tractive effort is reckoned positive under the direction of motion and the resistance is positive in the reverse direction. To-day by the use of a pendulum accelerometer, an improved type of which was designed by Mr. Lanchester in 1904, it is possible to take the most accurate readings. He showed diagrams of readings taken with this pendulum instrument concerning brake tests taken on various parts of the Great Western Railway system and on the Piccadilly Tube.

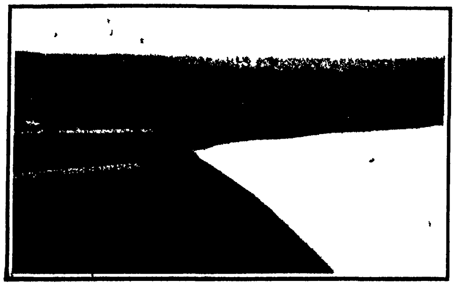
IDEAL AND ACTUAL METHODS CONTRASTED.

It is now well understood that the correct manner to brake a train or any other kind of vehicle, if the comfort of the passengers is to be considered, is to withdraw the brakes somewhat as the vehicle comes to rest, the ideal condition being that at the instant of coming to rest the brake effort should be zero. Of course in practice the most that could be done was very materially to diminish the extent of the brake effort, though in fact it was comparatively rarely that even that was done, because it was so easy for a driver to stop at a given place by reducing the speed to about five or ten miles an hour, then virtually to clamp the vehicle at the desired spot by the full application of the brake. On the other hand it required very great judgment and skill, as well as perfect mechanism, to stop at an exact place with a "tailing-off" brake diagram. In the case of railways the lecturer thought it was a question whether any great improvement would be made in this direction unless some automatic mechanism were adopted and actuated from the track itself. He pointed out that in regard to railway trains the rate of change of acceleration should be limited, and that the acceleration curves should be of smooth contour, never exceeding some specified gradient. Then there need be no artificial limit set on the maximum acceleration. Since a sudden change of acceleration resulted in the passengers' loss of equilibrium, if such sudden change took place it depended on what the actual acceleration was immediately afterward. He said that in vehicles such as urban electric tram cars a magnetic brake was frequently fitted. When it was used the acceleration was not limited by the ordinary considerations. The slipping limit no longer existed, for the friction was not dependent on the weight of the vehicle, but on the magnetic suction, which might be made as great as they pleased. If too powerful a magnetic brake were employed to the full, it might be just as dangerous to the life of the passengers as an actual collision. Passengers had been thrown from one end of a tram car to the other, and others had been unseated, by the injudicious using of such a brake. In that case we probably had both the sudden change of acceleration and an excessive maximum immediately succeeding. The first threw the passenger down, and the second prevented the least chance of his recovery.

PHOTOGRAPHING FROM AN AEROPLANE.

PICTURES TAKEN FROM LATHAM'S "ANTOINETTE."

Now that it is possible for an aeroplane pilot to carry as many as two persons beside himself various foreign aviators have tried the experiment of carrying dead weight of various kinds in place of the second passenger The two photographs reproduced herewith were taken by a photographer whom Latham recently took aloft with his camera at Lonvercy France They give a very good idea of the view one gets from a monoplane when in flight In one of them which was taken looking forward over the engine the halo of the propeller can be seen The same peculiar band occurs across this halo as can be noted in the front view of the propeller revolving which formed the frontispiece of our SCIENTIFIC AMERICAN issue of January 8th In that case the band appeared to be a shadow but in the present instance it seems to be an interruption in the halo, as the ground can be seen clearly at the band At the upper edge of this band a Farman biplane is seen flying at a lower elevation



THE AEROPLANE SHEDS AT LONVERCY AS VIEWED FROM THE ANTOINETTE MONOPLANE

SIDE VIEW FROM THE MONOPLANE SHOWING ANOTHER ANTOINETTE IN FRONT OF THE SHEDS

VIEW LOOKING FORWARD FROM ANTOINETTE MONOPLANE IN FLIGHT

The juncture of the main front longitudinals of the wings and the top of the 8-cylinder V type motor can be seen in the foreground Note also the halo of the propeller and the biplane flying below in the distance

SIDE VIEW ALONG REAR EDGE OF WING OF MONOPLANE

The trussing of the wing can be seen in this photograph [illegible] the upper main ribs which stand out through the cloth

By courtesy of L'Illustration

PHOTOGRAPHING FROM AN AEROPLANE

The second photograph was taken along the rear edge of the left wing of the monoplane It shows a road lined with trees on either side above which the aeroplane is soaring

Latham has also taken up a cinematograph and operator, and the moving pictures secured from the monoplane in flight are said to be very realistic

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EXPERIMENTS WITH WIRELESS WEATHER SIGNALS FROM THE NORTH ATLANTIC.

THE German and British meteorological offices conducted conjointly during the months of February March, and April, and again in August and September of last year, two series of experiments in the wireless transmission of weather indications from vessels traversing the North Atlantic Ocean. The result of the first series of experiments may be summarized in the statement that, although the telegrams were not more frequently unintelligible than occurs in ordinary telegraphing over land, yet the reported readings of the barometer were often erroneous and many of the messages arrived too late to be of service for weather prediction In the repetition of the experiments in August and September the field of observation was confined to the region from 10 to 30 deg of longitude west from Greenwich because the experiments in the spring had shown that telegrams from points beyond the 30th meridian never arrived early enough to be of use to the Weather Bureau

The observations were made at 7 A M and 6 P M Greenwich time They were transmitted from the German steamers to the coast stations of the Marconi company in the form of two groups of five figures each according to the scheme represented by the letters *BBWWDPPPNN* Here *BB* represent the barometric readings to the nearest millimeter reduced to 32 deg F and the sea level *WW* the direction and force of the wind and *D* the date of the month denoted by its unit figure alone In the second group the numbers *NN* indicate the name of the ship *PPP* its position and the hour of observation The German field of observation was divided into 00 sections of 1 degree in longitude and latitude which for the morning observations were numbered from 0 0 0 to 499 while the same positions for the afternoon observations were designated by adding 00 in each case For example the following double group was received on September 22nd "58852 - 16608 This is interpreted as follows Steamer Pennsylvania" (08) between 28 and 29 W Long and 49 and 50 N Lat on Sept 22nd at 7 A M Greenwich time barometer 758 millimeters wind N N W velocity of wind 1 to 3

Forty nine English steamers sent 568 telegrams during 181 trips and 23 German steamers sent 276 telegrams on 74 trips For the usefulness of the wireless system for the German Weather Bureau the time of the arrival of the signals in Germany is of especial importance Under the assumption that messages reaching a weather bureau at or before 10 30 A M are available for use a period of 2½ hours can be allowed for the transmission of the morning observations and 15½ hours for the evening observations During the 61 days of the experiment 422 morning observations and 439 evening observations were transmitted. Of these 188 of the evening observations but only 31 of the morning observations arrived in time to be of use in weather prognostication

In regard to the most important point i e the usefulness of wireless signals in the service of the Weather Bureau Prom thens observes that during the months of August and September not a single prediction of the Hamburg Weather Bureau was appreciably influenced by any wireless message This result may however depend very largely upon the fact that during this period as well as in the months of the spring experiments an area of high pressure extending westward from the British Islands was very frequently observed In this condition of the atmosphere the distribution of pressure over the Atlantic Ocean exerts very little influence upon the coming weather in Germany Even when the messages which had arrived too late for the compilation of the weather predictions were subsequently taken into account in the great majority of cases no important deviation was produced from the distribution of pressure over the ocean as originally deduced from barometric observations in Iceland and the Azores Nevertheless the timely arrival of the evening messages might often be of great value for example in those cases in which a minimum of pressure has moved from the ocean to the British Islands during the night when the prediction of the subsequent course of this minimum would be greatly facilitated by a knowledge of its position on the preceding evening In the present state of wireless telegraphy a similar utilization of the morning observations which would be of still greater value is unfortunately not to be thought of On the whole the advantages to be expected from the employment of wireless telegraphy in the German Weather Service are yet too small to warrant any further experiments in the wireless transmission of observations made at sea For the permanent introduction of the wireless system we must wait until the progress of wireless telegraphy shall have made it possible for vessels to extend their radius of action without increase of expense.

FLYING IN THE FUTURE.*

THE MACHINE AND THE AVIATOR SOME YEARS HENCE.

BY CHARLES CYRIL TURNER.

What will the flying machine of the future be like? That there will be considerable specialization of machines for specific purposes is certain and while some authorities are convinced that the monoplane principle is a good one there is obviously material for much interesting differentiation This differentiation will in the main respond to certain demands We can clearly foresee development with both monoplane and biplane

The racing aeroplanes will probably be monoplanes with comparatively small lifting surface high speed giving the necessary lifting power The racing aeroplane will not carry a great weight and the power of the engine will be required for driving at a great speed without more waste of energy than is unavoidable It is of course an axiom that the greater the speed the less the waste of power Monoplanes will very probably develop into a permanent racing type

It is unwise to jump hastily into advocacy of any one type There has not yet been a scientific test of the various types of machines Until we classify machines according to different grades such as area of plane method of control weight etc and have class competitions on scientific lines we shall not advance sensibly toward the elimination of the less fit

A hasty judgment on the basis of the Blackpool and Doncaster meetings would have placed the Farman biplane at the top at both the Antoinette as the best monoplane at Blackpool and the Blériot as the best monoplane at Doncaster But there was no extended trial of other machines at these meetings At Rheims many machines flew but there was no classified testing

Major Baden Powell reporting in the Journal of the Aeronautical Society on the Rheims meeting found that the Curtiss biplane and the Blériot monoplane were the speediest the Antoinette second and the Wright third The Voisin biplane was the slowest of all Of these machines the Blériot was the heaviest in relation to size of sustaining plane the Wright was the lightest the Antoinette nearly as light as the Wright

The Blériot carried about pounds per square foot of the area the Wright less than pounds the Antoinette pounds the Curtiss 2½ pounds Thus the heaviest and the lightest of the machines were among the fastest

Perhaps the more exhaustive tests which will be made this year will elucidate some of these points

I think the near future will see machines in which three or four passengers can be carried and in which the control can be in the hands of two pilots Sooner or later we shall get the machine attempted with two motors instead of one And quite certainly we shall have the machine with variable lifting surface and variable power

We know that an aeroplane can descend safely onto water Latham did that in his attempt to cross the Channel Soon we shall have machines that can ascend from water

It is not altogether uninstructive to pay attention to the imagination of the novelists when they are thinkers of the caliber of Mr Kipling and Mr Wells

The imagination of Mr Wells in When the Sleeper Wakes gives a view of the world some 300 years hence when flying machines are supposed to have become the ordinary instruments of locomotion Mr Wells describes two kinds of these machines One is a big aeroplane carrying some hundreds of passengers the other is a small very active aerial top carrying but one or two persons and buzzing about like a fly

Mr Kipling shows us the transatlantic mails carried by airship driven by powerful motors and equipped with a remarkable rudder called the Magniac after its inventor

The rudder that assured us the dominion of the unstable air and left its inventor penniless and half blind It is calculated to Castelli's gull wing curve Raise a few feet of that all but invisible plate three eighths of an inch and she will yaw five miles to port or starboard ere she is under control again Give her full helm and she returns on her track like a whip lash Cant the whole forward—a touch on the wheel will suffice and she sweeps at your good direction up or down Open the complete circle and she presents to the air a mushroom head that will bring her up all standing within a half mile

Nobody but Mr Kipling could have written that It should be an inspiration to the inventor This airship is gas lifted and the gas is kept well in hand by the use of Fleury Ray which reduces it to liquid and again to fully efficient gas at will A wonderful story if only for the aeronautical terms employed many of which will come into use in our time

Mr Kipling by the way looking back at our own feeble efforts at flight talks with scorn of 'the days when men flew wooden kites over oil engines

We have spoken of possible developments of the flying machine but there are and will remain limitations One limitation is that of cost The cost of an aeroplane is principally that of the motor and with types becoming standardized the price of an aero motor will probably come down to $1,000 or so An aeroplane costs from $2,000 to $7,500

Then we have the prospect of a considerable degree of standardization of parts permitting the cost of manufacture to be considerably reduced Probably the cost of a flying machine power for power will be no more than two thirds of that of a motor car On the score of cost of machines then there is nothing to prohibit a great extension of the community of flyers But this cheapening depends upon the creation of a certain demand and the demand depends first of all upon facilities for flying

But one other expense has been mentioned that of depreciation Wet weather plays havoc with flying machines and since the life of the pilot depends upon the reliability of each single wire there will have to be some development in the way of weather proof machines We must have metal work that does not rust and fabric that does not rot The pilot will have to take more care of his planes and framework than he did at Doncaster and Blackpool Otherwise a machine that cost $[illegible],000 will depreciate in value 50 per cent in a month

As to facilities for flying practice the use of public commons and parks will of course be denied to the aeroplanist The solution of the problem will be found in a rapid extension of the practice of aeronautical societies acquiring grounds for flight and then swift progress from this beginning With the extension of flying societies of flyers will spring up everywhere and will acquire private ground just as for motor cycle and horse racing private ground has for a long time past been preserved These flying grounds will be maintained by the subscriptions of members, and by gate money

It is natural and necessary to start with your private aeroplaning grounds But once your aviator is in the air he will fly beyond There may be flights from one ground to another and various inter club competitions

Very early a demand will spring up for maps showing suitable descending places and municipalities will be asked to mark out available lands There is already rivalry among the watering places and holiday resorts in the matter of providing facilities for aviation Frequented routes will have landing and supply stations at intervals of ten miles or so

I do not believe that we need be dismayed because the flying machine at present requires a long start on the ground There are many railway stations in London to which the public only have access by ascending many stairs or descending in lifts Yet they are used by the patient long suffering public With the extension of flying we shall have plenty of suitable starting and alighting places And that is not taking account of the possibility of improvements in machines

It is common to hear the numerous limitations of the flying machine urged against it but I think we might with reason remember how short is the time during which men have flown and how recently it is that they have been able to gain experience in the air Progress has been very rapid in the past two years and great developments in the motor in aeroplane construction as well as in dirigible ballooning are imminent

Finding the way in the air is difficult Needless to say the aeronaut must take a compass The best form of compass is the prismatic by which directions can be taken with very great accuracy all the time fixed objects on the earth are visible This compass should have a dial covered with luminous material visible at night For employment upon aeroplanes it is necessary to have a compass immune from the influence of the magneto of the motor This disturbing influence will probably be overcome in the same way as on the torpedo boats There the compass is greatly interfered with by the machinery, but tests are made and the amount of deflection ascertained. Then magnets are placed in such a position as to correct the variation

A gyroscope compass may be possible Once a gyroscope has been set spinning at a sufficient rate in a certain plane it will remain in that plane Start it spinning in the plane that runs north and south and it will remain in it not subject to magnetic or other disturbances

Keeping a straight course is possible all the while land is in sight For it is simply necessary to take your line with two fixed objects Naturally when one pilot has to do all this and attend to the machine and motor he has not any leisure to speak of

We have seen that an airship can if its velocity be superior to that of the wind make for its destination with due allowance for drifting If you cannot see the earth however and cannot take a meridian you may go far out of your course A little instrument has been brought out to enable the true direction of an airship to be readily determined at any time that is to say the direction resulting from the forward motion and any drifting motion which from any cause may be set up but it is only of use when the ground is visible or when the aeronaut is fairly certain of the direction and velocity of the wind Flying by night or over clouds presents difficulties unless the balloonist or aeroplanist can see fixed objects He cannot tell how much he may be drifting astray on a big current of air

To balloonists whether in a spherical or a dirigible balloon an electric indicator on the trailing rope is useful at night The drag of the trail rope along the ground causes the end in the car to make contact with an electric indicator which at once rings a bell warning the aeronaut when he may not be able to see, that he is near the ground and that it may be necessary to discharge ballast in order to avoid striking something in the dark

Special maps are necessary for aerial navigation It is very difficult to recognize familiar country from above and the ordinary map is of very little use in informing the aeronaut of his whereabouts if he is over strange country The familiar landmarks are not recognizable With a map on a scale of half an inch to the mile, showing the lines of the roads and the shapes of the villages it is often easy enough to ascertain the locality but the aeronaut travels swiftly and a full equipment of half inch scale maps would be a serious item in the weight of his load Moreover he is often above clouds for a considerable period and then when he views the earth again it is very difficult and frequently impossible to pick up the locality by a study of the map The aeronaut in the flying machine or the dirigible balloon is more favorably placed than in the ordinary balloon He knows his direction approximately although he is as we have seen often unable to make proper allowance for the drifting effect of the wind and if caught by varying currents or by storms above the clouds he easily loses track of the course of his flight

'Relief' maps are of little use and there will be need for the construction of large distinctive ground marks for day and lights for night time at distances about ten miles or so apart indicating by number or shape the localities These marks would of course correspond with marks on the chart They could be different in color and in shape and each county might have its special mark on the basis possibly of the motor car registration letters

Zeppelin proposes maps showing different heights by color with streams, marshes, and woods indicated as influencing the static equilibrium of the airship The scale he suggests is three miles to the inch but this of course is rather for balloonists than for aeroplanists Color is the main consideration and the color, I am convinced by my own experience should approximate to the colors of the landscape as seen from above The roads should be in white, the water blue, the fields light green, woods a darker green, habitations gray railways black, very much as these general features appear from above. Roads and the lines with which they converge on a town taken in conjunction with railways and water, I have always found are the surest guides to locality

Combined with that of marks to guide the aerial traveler in locality and direction is the question of conveying useful information to him It will often be of great importance to him to know the strength and exact direction of the wind. It may not be possible for him to ascertain these with absolute accuracy while he is in flight, by his own observations. The

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* Journal of the Society of Arts

German Aerial Navy League has brought forward a useful idea in this connection, suggesting special lighthouses. Those are to send a long beam of light in the direction in which the wind is blowing. But to make the service thus rendered more particular, would it not be better to have a long white indicator with a conspicuously painted arrow, and some method of marks to indicate the strength of the wind?

We turn to Mr Kipling for guidance and we get a picture of an aerial world illuminated from below by colored beams that pierce through thick strata of clouds.

"Bristol and Cardiff double lights (those statelily inclined beams over Severnmouth) are dead ahead of us; for we keep the southern winter route. Coventry Central, the pivot of the English system, stabs upward once in ten seconds its spear of diamond light to the north, and a point or two off our starboard bow. The Leek, the great cloud breaker of St David's Head, swings its unmistakable green beams 25 degrees each way There must be half a mile of fluff over it in this weather, but it does not affect the Leek 'Our planet's overlighted, if anything,' says Capt. Purnall, at the wheel"

TURBINES IN WARSHIPS.

THEIR PRESENT STATUS.

The marine steam turbine is in a very uncertain position as far as its future design is concerned Excellent as it is in many ways there is much about it that is not entirely satisfactory, and considerable changes must be looked for before long in the technical features of the design It is, at present—we speak generally of both the Parsons and Curtis types, the only two that offer serious probabilities of survival well proved to be economical, its durability is beyond question, while its intrinsic suitability for marine propulsion may be gaged from the fact that there is now somewhat over 6 million horse power at work or under construction Nevertheless could the answer be freed from all bias, it would be difficult to say exactly what is really the best arrangement of turbine machinery for warship work That the British Admiralty is uncertain is shown by the widely differing types of arrangements that we find in the "Amethyst," "Dreadnought," "Bristol," "Newcastle," and "Orion" The German and United States Admiralty Engineering Departments are equally uncertain what type of machinery to install Each is adopting Parsons turbines on four shafts Curtis on two or three or reciprocating engines Generally speaking, the difference between three and four shafts is settled by the question of horse power and revolutions, or to go into greater detail, by initial blade height in the turbine

But assume the same class of ship a "Neptune" for example, of 25,000 horse power and 21 knots—what is the best type that can be adopted? When the "Dreadnought" was built there was no question other types had not been developed—but now matters are different To anyone who has seen the stern of the "Vanguard," with her four 9 foot screws, and compared it with that of the "St Paulo" both vessels are being completed at Barrow at the present time with two of 18 foot diameter, there can be no doubt of the greater advantages of the twin screw But what of the turbine? Triple screws have never been favored in this country, but they are being tried in the new German turbine battleship, which in this particular follows previous practice Four shafts appear to complicate a stern very much, but for very fine ships, where the wing propellers can be placed far ahead of the inner ones, the results obtained have been good When the screws have not been sufficiently separated the results have been poor—very poor The main objections that can be raised to most existing warship arrangements are the use of cruising turbines and the adoption of separate astern turbines The former are useless weight at full speed, besides being a most unnecessary brake on the main turbines, at low speeds the value in lowering consumption ranges from practically *nil* in large vessels to a measurable, but very small, amount in destroyers and only in these because of the extraordinary range of power at which such vessels are steamed The same weight in either type of ship applied to fuel would be of far greater value and reduce the complication Separate astern high pressure turbines are just as bad They brake the ahead turbine, they are relatively very heavy, and add equally to the complication Is it really necessary to reverse all the shafts of a four shaft vessel? The "Mauretania" has only two shafts so fitted out of four, and there are various other vessels like her Quite apart from many debatable points of detailed mechanical design, these features alone justify our asking seriously if we have really got the best design? Are matters not in a state of uncertainty because of the patent position and a desire to avoid additional complications or royalties? Or is it, perhaps, that having adopted one style, there is some hesitation in certain quarters to blend with it some of the salient features of another? Much more important to the navy or to those interested in steamship propulsion generally would be an unbiased answer to the question, Would it not give us a better engine if we did blend the better features of the two turbine systems now in vogue? In the newer large ships of the navy, cruising turbines are abandoned, but separate high pressure astern turbines remain The high pressure ahead turbine is lengthened by one stage of blading, which is meant to act as a cruising turbine below certain speeds, for higher speeds the steam is by passed to the second or third stage The blades in this initial stage are necessarily short and relatively inefficient Can this be called a good mechanical system for obtaining low power economy? Is it likely to remain as a permanent feature in turbine design? A four shaft "Neptune" has four propellers about 9 feet diameter, revolving at 320 revolutions. If fitted with three shafts the screws would be 10 feet 6 inches diameter, and revolve at 280 revolutions, while twin screws would require to be 13 feet diameter and revolve at 225 Suppose we made them 14 feet instead, and ran them at 210, could we not get a better propeller efficiency than with four of 9 feet diameter where the wing screws, owing to the full nature of the ship, must interfere with the inner screws There is no doubt that this is possible Again we ask what of the turbine? Take the existing low pressure turbine, and increase the mean diameter in the ratio of 320/210 and reduce the blade height to give the same area through the blades as before This turbine will not be quite so efficient, owing to relatively greater leakage over the blade tips but the blades will be shorter, and therefore narrower and of smaller pitch In the same total length it will be possible to add the requisite few rows to keep the economy of the low pressure turbine the same The difficulty lies in the arrangement of the high pressure portion We have seen how the propeller efficiency is improved and the efficiency of the low pressure portion maintained as before, even a slight reduction in the previous efficiency of the high pressure portion—only 50 per cent of the power might be allowed and still leave a gain in total efficiency The mechanical features of an impulse high pressure portion composed of either one or two velocity compounded stages present some little difficulty whether the revolving blades be mounted on a drum or on disks, as in the Curtis design But such an arrangement allows the use of only one cylinder for each unit Nozzles can easily be shut off independently if cruising conditions are required there is no separate astern cylinder, and no mazed complication of valves to handle as in case where there are two cruising turbines in series, and one side is required to go ahead and the other astern The practical difficulty of having a very heavy rotor to handle is certainly an objection but not a serious one but the advantage of two shafts over three or four with all the bearings glands, and stuffing boxes is a very real one—to the man in charge If the high pressure modification can be carried out efficiently there will be a gain to the owner of the installation too

There is no doubt that there is a strong tendency towards this development of the twin screw turbine at present All the Argentine destroyers are to have twin screws, all the latest German destroyers have, and they have proved amply successful Is it certain that the five cylinder complication on three shafts as adopted in all the 1908 and 1909 British destroyers is really the best? If not, it is hard to see why One difficulty in adopting twin screws lies in the case of limited drafts of water, then three may have to be used Even so, is not the single cylinder type of turbine one complete unit per shaft—likely to be the ultimate solution? There is nothing strikingly novel in the combination of one type for the high pressure end of the turbine and another type for the low pressure The system has been widely adopted for land turbines—originally by Mr Westinghouse in America, we believe—but for marine work there are mechanical difficulties to overcome Once these by no means insuperable points have been arranged for, this system is practically sure to replace the more costly and complicated one to which however, engineers must always award full credit for being that which originally demonstrated the possibility of the application of turbines to ship propulsion—The Engineer.

THE ENERGY OF A STEAM BOILER.

The explosion of a boiler is not an instantaneous action, but a series of well defined but rapidly-succeeding operations. If the break occurs below the water line, it is possible that no explosion will ensue, as the situation of the break is not favorable for the production of water hammer, and the boiler will relieve itself of its pressure by the water issuing out first. But if the break be above or near the water line, the circumstances are favorable to the production of water hammer, and a violent explosion may occur.

The method of explosion, in most instances, seems to be the opening of a small orifice at a point where the resistance offered by the material is less than the stress to which it is subjected, followed by an outrush of steam or water, or both; the extension of the rupture to the adjoining parts when these parts become too weak to sustain the increased stress which the break already made puts upon them, this operation being so sudden that sufficient time is not allowed for the gradual escape of the inclosed fluids; and the boiler is torn violently into fragments, and distributed far and wide by the steam generated from the liberated water.

An explosion does not ensue if the parts adjacent to the initial rupture possess sufficient strength, and it is probable that explosions do not occur unless the strength of the boiler is quite uniform, but less than that required to sustain the pressure. Local weakness is a safety valve that permits a rupture, and insures again a general disrupture

Minor defects surrounded by strong parts merely relieve the pressure; but a long seam weakened by corrosion or "burning" of the lap, a considerable area of plate thinned by corrosion or weakened by overheating, or an extended crack, may be the occasion of a disastrous explosion

The energy in a cubic foot of highly heated water is equal to the energy in a pound of gunpowder. Most of the energy in a steam boiler under pressure is contained in the water and only a relatively small amount of the energy in the steam. Take, for instance, the case of a horizontal tubular boiler carrying 150 pounds pressure, and having 160 cubic feet of water space and 80 cubic feet of steam space The water weighs 160 × 62.4 = 9,984 pounds, and the steam weighs 80 × 0.3671 = 29.37 pounds.

The energy in each pound of water at 150 pounds pressure that would be liberated by explosion and expansion down to 212 deg F is 11,823.4 foot-pounds, and the energy in each pound of steam at the same pressure is 134,521.2 foot pounds. The total energy in the water is therefore, 9,984 × 11,823 = 118,040,832 foot pounds, and the total energy in the steam is 29 37 × 134,521 = 3,950,882 foot-pounds. The energy in the steam is consequently less than 4 per cent of that in the water. The water is the more dangerous content of the boiler.

The total energy in the water and steam is 118,040,852 + 3,950 882 = 121,991,711 foot pounds If the boiler weighs, say, 10,000 pounds, and if all of this energy were expended in an explosion in projecting the boiler vertically, then, neglecting the friction of the air, the boiler would rise to a height of 12,199 feet, or over two miles.—Bulletin of the Fidelity and Casualty Company

According to a contemporary, Prof Osann holds that the advantages of the dry blast are mainly confined to furnaces that do not run well under ordinary conditions, but consume an unduly large amount of coke, the usual cause being that the sectional area of the furnace has become lessened In view of this circumstance and of the high cost of fitting up a large dry-air plant, he recommends that, for a group of furnaces, the drying plant should be merely large enough to supply one of them—the largest, if there be any difference in their size—with dry blast, arrangements being made for coupling up this plant to any of the blowing engines By using the drying plant only when any of the furnaces begin to go wrong the deterioration may be retarded and prevented from becoming chronic This would reduce the cost of dry blast considerably; and, by making provision for admitting controllable amounts of steam into the dry blast, it would also be possible to remedy other working defects of the furnaces.

PROGRESS IN WIRELESS TELEGRAPHY.—II.*

A NOBEL PRIZE LECTURE.

BY GUGLIELMO MARCONI.

Concluded from Supplement No 1782, Page 142.

A matter of scientific interest which I first noticed during the tests on the steamship Philadelphia and which is a most important factor in long distance radio telegraphy was the very marked and detrimental effect of daylight on the propagation of electric waves at great distances the range by night being usually more than double that attainable during daytime I do not think that this effect has yet been satisfactorily investigated or explained At the time I carried out the tests I was of opinion that it might be due to the loss of energy at the transmitter caused by the discharge [illegible] fication of the highly charged transmitting elevated conductor under the influence of sunlight

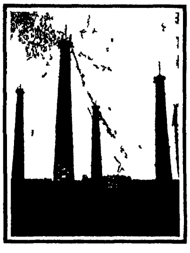

Fig 15

I am now inclined to believe that the absorption of electric waves during the daytime is due to the ionization of the gaseous molecules of the air affected by ultra violet light and as the ultra violet rays which emanate from the sun are largely absorbed in the upper atmosphere of the earth it is probable that the proportion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness and therefore as Sir J J Thomson has shown this illuminated and ionized air will absorb some of the energy of the electric waves Apparently the length of wave and altitude of electrical oscillations have much to do with this interesting phenomenon long waves and small amplitudes being subject to the effect of daylight to a much lesser degree than short waves and large amplitudes According to Professor Fleming the daylight effect should be more marked on long waves but this has not been my experience Indeed in some very recent experiments in which waves about 8000 m long were used the energy received by day was usually greater than at night The fact remains however that for comparatively short waves such as are used for ship communication clear sunlight and blue skies though transparent to light act as a kind of fog to these waves Hence the weather conditions prevailing in England and perhaps in this country (Sweden) are usually suitable for wireless telegraphy

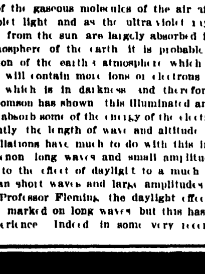

Fig 16

During the year 190 I carried out some further tests between the station at Poldhu and a receiving installation erected on the Italian cruiser Carlo Alberto kindly placed at my disposal by H M the King of Italy[3] During these experiments the interesting fact was observed that even when using waves as short as 1 000 feet intervening ranges of mountains such as the Alps or Pyrenees did not during the night time bring about any considerable reduction in the distance over which it was possible to communicate During daytime unless much longer waves and more power were used intervening mountains greatly reduced the apparent range of the transmitter Messages and press dispatches of considerable length were received from Poldhu at the positions marked on the map which map is a copy on a reduced scale of the one accompanying the official report of the experiments—Fig 16

With the active encouragement and financial assistance of the Canadian government a high power station was constructed at Glace Bay Nova Scotia in order that I should be able to continue by long distance tests with a view to establishing radio telegraphic communication on a commercial basis between England and America[4] On December 16th 1902 the first official messages were exchanged at night across the Atlantic between the stations at Poldhu and Glace Bay Figs 15 and 16 Further tests were shortly afterward carried out with another long distance station at Cape Cod in the United States of America and under favorable circumstances it was found possible to transmit messages to Poldhu 000 miles away with an expenditure of electrical energy of only about 10 kilowatts

In the spring of 190 the transmission of press messages by radio telegraphy from America to Europe was attempted and for a time the London Times published during the latter part of March and the early part of April of that year news messages from its New York correspondent sent across the Atlantic without the aid of cables A breakdown in the insulation of the apparatus at Glace Bay made it necessary however to suspend the service and unfortunately further accidents made the transmission of messages uncertain and unreliable As a result of the data and experience gained by these and other tests which I carried out for the British government between England and Gibraltar I was able to erect a new station at Clifden in Ireland and enlarge the one at Glace Bay in Canada so as to enable me to initiate in October 1907 communication for commercial purposes across the Atlantic between England and Canada Although the stations at Clifden and Glace Bay had to be put into operation before they were altogether completed nevertheless comunication across the Atlantic by radio telegraphy never suffered any serious interruption during nearly two years until in consequence of a fire at Glace Bay this autumn it has had to be suspended for three or four months This suspension has not however been altogether an unmitigated evil as it has given me the opportunity of installing more efficient and up to date machinery

The arrangements of elevated conductors or aerials which I have tried during my long-distance tests are shown in Figs 17 18 and 19[5] The aerial shown in Fig 19 consisted of a nearly vertical portion in the middle 220 feet high supported by four towers and attached at the top to nearly horizontal wires 200 in number and each 1 000 feet long extending radially all round and supported at a height of 180 feet from the ground by an inner circle of 8 and an outer circle of 16 masts The natural period of oscillation of this aerial system gave a wave length of 12 000 feet Experiments were made with this arrangement in 1905 and with a wave length of 12 000 feet signals, although very weak could be received across the Atlantic by day as well as by night The system of aerial I finally adopted for the long distance stations in England and Canada is shown in Fig 20 This arrangement not only makes it possible efficiently to radiate and receive waves of any desired length but also tends to confine the main portion of the radiation to a given direction The limitation of transmission to one direction is not very sharply defined but the results obtained with this type of aerial are nevertheless exceedingly useful

Many suggestions respecting methods for limiting the direction of radiation have been made by various workers notably by Prof F Braun Prof Artom, and Messrs Bellini and Tosi In a paper read before the Royal Society in London in March 1906[6] I showed how it was possible by means of horizontal aerials to confine the emitted radiations mainly to the direction of their vertical plane pointing away from their earthed end In a similar manner it is possible to locate the bearing or direction of a sending station The transmitting circuits at the long distance stations are arranged in accordance with a comparatively recent system for producing continuous or slightly damped oscillations which I referred to in a lecture before the Royal Institution of Great Britain on March 13th 1908 An insulated metal disk *A* Fig 21 is caused to rotate at a high rate of speed by means of an electric motor or steam turbine Adjacent to this disk which I will call the middle disk are placed two other disks *C* and *C* which may be called polar disks and which are also revolved These polar disks have their peripheries very close to the surface or edges of the middle disk The two polar disks are connected by rubbing contacts to the outer ends of two condensers *K* joined in series and these condensers are also connected through suitable brushes to the terminals of a generator which should be a high tension continuous current generator On the middle disk a suitable brush or rubbing contact is provided and between this contact and the middle point of the two condensers an oscillating circuit is inserted consisting of a condenser *E* in series with an inductance which last is inductively connected with the radiating antennæ The apparatus works probably in the following manner The generator charges the double condenser making the potential of the disks, say *C'* positive and *C''* negative The potential, if high enough will cause a discharge to pass across one of the gaps say between *C'* and *A* This charges the condenser *E* through the inductance *F* and starts oscillations in the circuit. The charge *F* in swinging back will jump from *A* to *C''*, the potential of which is of opposite sign to *A* the dielectric strength between *C'* and *A* having meanwhile been restored by the rapid motion of the disk, driving away the ionised air The condenser *E* therefore discharges and recharges alternatively in reverse directions, the same process going on so long as energy is supplied

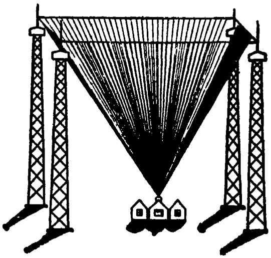

Fig 17

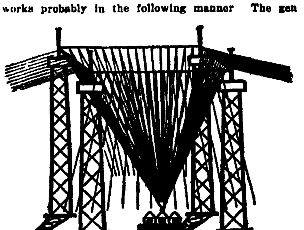

Fig 18

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* Address delivered in Stockholm by Mr Marconi on the occasion of the awarding of his share of the Nobel prize

See Proceedings of the Royal Society Vol LXX "A Note on the Effect of Daylight upon the Propagation of Electromagnetic Impulses" G Marconi June 1 th 1902

See Philosophical Magazine August 190 Ser 6 Vol IV, p 253, J J Thomson, "On Some Consequences etc"

[3] See Rivista Marittima Rome October 1902

[4] See paper read before the Royal Institution of Great Britain by G Marconi March 3rd 1905

[5] See also lecture before the Royal Institution of Great Britain by G Marconi, March 13th, 1908.

[6] "On Methods whereby the Radiation of Electric Waves may be Mainly Confined, etc," "Proceedings" of the Royal Society, A Vol. 77, 1906.

to the condensers *K* by the generator *H* It is clear that the discharges between *C'* and *C''* and *A* are never simultaneous, as otherwise the center electrode would not be alternatively positive and negative

The best results have, however been obtained by an arrangement as shown in Fig 22 in which the active surface of the middle disk is not smooth but consists of a number of regularly spaced copper knobs or pegs, at the ends of which the discharges take place at regular intervals In this way it is possible to cause the groups of oscillations radiated to reproduce a high and clear musical note in a receiver and thereby it is easier to differentiate between the signals emanating from the sending station and noises caused by atmospheric electrical discharges By this method very efficient resonances can be also obtained in appropriately designed receivers

With regard to the receivers employed important changes have taken place By far the larger portion of electric wave telegraphy was until a few years ago conducted by means of some form or other of coherer or variable contact either requiring tapping or self restoring At the present day however I might say that in all the stations controlled by my company my magnetic receiver is almost exclusively employed Fig 23[*] This receiver is based on the decrease of magnetic hystereses which occur in iron when under certain conditions this metal is subjected to the effects of electrical waves of high frequency It has recently been found possible to increase the sensitiveness of these receivers and to employ them in connection with a high speed relay so as to record messages at great speed

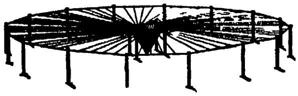

FIG 19

A remarkable fact not generally known in regard to transmitters is that none of the arrangements employing condensers exceeds in efficiency the plain elevated aerial or vertical wire discharging to earth through a spark gap as used in my first experiments Figs 2 and 3 (*ante*) I have recently been able to confirm the statement made by Prof Fleming in his book The Principles of Electric Wave Telegraphy 1906 page 555 that with a power of 8 watts in the aerial it is possible to communicate to distances of over 100 miles I have also found that by this method it is possible to send signals 2 000 miles across the Atlantic with a smaller expenditure of energy than by any other method known to myself

The only drawback to this arrangement is that unless very large aerials are used the amount of energy which can be efficiently employed is limited by the potential beyond which brush discharges and the resistances of the spark gap begin to have a deleterious effect By means of spark gaps in compressed air and the addition of inductance coils placed between the aerial and earth the system can be made to radiate very pure and slightly damped waves eminently suitable for sharp tuning In regard to the general working of wireless telegraphy the widespread application of the system and the multiplicity of the stations have greatly facilitated the observation of facts not easily explainable Thus it has been observed that an ordinary ship station utilising about half a kilowatt of electrical energy the normal range of which is not greater than 200 miles will occasionally transmit messages across a distance of over 1 200 miles It often occurs that a ship fails to communicate with a nearby station but can correspond with perfect ease with a distant one

On many occasions last winter the steamship Caronia," of the Cunard Line carrying a station utilizing about half a kilowatt, when in the Mediterranean off the coast of Sicily, failed to obtain communication with the Italian stations but had no difficulty whatsoever in transmitting and receiving messages to and from the coasts of England and Holland although these latter stations were considerably more than 1,000 miles away and a large part of the continent of Europe and the Alps lay between them and the ship

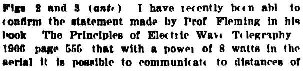

FIG 20

Although high power stations are now used for communicating across the Atlantic, and messages can be sent by day as well as by night, there still exist short periods of daily occurrence during which transmission from England to America, or *vice versa* is difficult Thus in the morning and evening when in consequence of the difference in longitude daylight or darkness extends only part of the way across the ocean the received signals are weak and sometimes cease altogether It would almost appear as if electric waves in passing from dark space to illuminated space and *vice versa* were reflected in such a manner as to be diverted from their normal path It is probable that these difficulties would not be experienced in telegraphing over equal distances north and south on about the same meridian as in this case the passage from daylight to darkness would occur almost simultaneously over the whole distance between the two points

Another curious result on which hundreds of observations continued for years leave no further doubt is that regularly for short periods at sunrise and sunset and occasionally at other times a shorter wave can be detected across the Atlantic in preference to the longer wave normally employed Thus at Clifden and Glace Bay when sending on an ordinary coupled circuit arranged so as simultaneously to radiate two waves one 12 000 feet and the other 14 700 feet although the longer wave is the one usually received at the other side of the ocean regularly about three hours after sunset at Clifden and three hours before sunrise at Glace Bay the shorter wave alone was received with remarkable strength for a period of about one hour This effect occurred so regularly that the operators tuned their receivers to the shorter wave at the times mentioned as a matter of ordinary routine

With regard to the utility of wireless telegraphy there is no doubt that its use has become a necessity for the safety of shipping all the principal liners and warships being already equipped its extension to less important ships being only a matter of time in view of the assistance it has provided in cases of danger Its application is also increasing as a means of communicating between outlying islands and also for the ordinary purposes of telegraphic communication between villages and towns especially in the colonies and in newly developed countries However great may be the importance of wireless telegraphy to ships and shipping I believe it is destined to an equal position of importance in furnishing efficient and economical communication between distant parts of the world and in connecting European countries with their colonies and with America As a matter of fact I am at the present time erecting a very large power station for the Italian government at Coltano for the purpose of communicating with the Italian colonies in East Africa and with South America

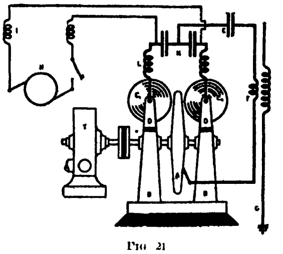

FIG 21

Whatever may be its present shortcomings and defects there can be no doubt that wireless telegraphy even over great distances has come to stay and will not only stay but continue to advance If it should become possible to transmit waves right round the world it may be found that the electrical energy traveling round all parts of the globe may be made to concentrate at the antipodes of the sending station In this way it may some day be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy and therefore at a corresponding small expense But I am leaving the regions of fact and entering the regions of speculation which however with the knowledge we have gradually gained on the subject promise results both useful and instructive

BAMBOO PAPER

CONSUL S C REAT of Tamsui furnishes the following information concerning Formosan bamboo pulp and the manufacture of paper therefrom in Japan

Will the world's future supply of paper pulp be derived from the bamboo forests of the tropics instead of being drawn from the forests of the temperate zones? A tentative affirmative answer to this question could be made by the Mitsu Bishi Paper Mill Company which has recently made very satisfactory experiments with bamboo pulp at its scientific station near Kobé, Japan

This company has the utmost confidence in the results of its experiments with bamboo pulp It has been granted a perpetual lease of 8 000 acres of bamboo forest in Formosa and is now engaged near Kagi in installing the machinery for a plant with a capacity of 300 tons of bamboo pulp a month and the capacity can easily be enlarged to 600 tons a month

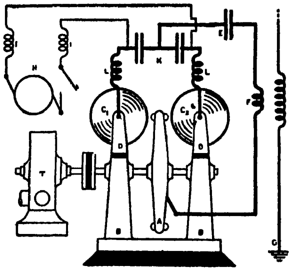

FIG 22

The making of paper from bamboo is not a recent discovery For generations the Chinese have carried on this industry in their homes but their methods are exceedingly primitive no chemicals entering into their process The Chinese use only bamboo shoots for the evident reason that the shoots can be more readily worked up

The new company will use all kinds of bamboo young and old but particularly a variety called kei chiku of which there is an unlimited quantity The question of the supply of raw material will never puzzle the company for the growth of bamboo is very rapid It verily grows inches in a night

The experiments so far have been made by mixing bamboo pulp and wood pulp in varying proportions according to the quality of paper desired But it is intended later to make paper entirely from bamboo pulp the only difficulty standing in the way of that process now is that the cost of an entire bamboo paper is more than the cost of wood pulp paper It is expected that all the machinery of this company will be installed and the plant will be in full operation by June 1910 The process employed will be a modified sulphite specially prepared by the company from bamboo There are eight different stages in the manufacture (1) The preparation of the bamboo by chopping into small pieces from one to two inches in size (2) cooking or digesting in a digester with sulphite of calcium (3) washing with water (4) bleaching with powder or electricity and washing again (5) drawn through a machine to press into the form of web (6) drying by steaming (7) rolled by winding machine or cut into sheets

The pulp will be shipped to Japan in the form of rolls or sheets where it will be manufactured into two grades of paper news and book On the Formosan pulp factory and on the mills at Kobé where the finished bamboo product will come forth much interest will be centered by the great paper industries of the world

At Haltem, in Westphalia near the site of the Aliso fortress erected by Drusus in the year 11 B C was recently found a bronze vessel containing a dried black mass which Prof Kassner has decided to be Roman ink The mass was found to consist chiefly of soot and tannate of iron It also contained smaller quantities of ferric oxide copper oxide clay magnesia gypsum phosphoric acid carbonic acid alkalies and sand These ingredients probably represent chiefly accidental impurities which have found their way into the old inkstand but some of them may be due to the chemical action of the ink on the bronze vessel The presence of an aromatic substances suggests that the ink was imported from Italy where the use of perfumed ink was common

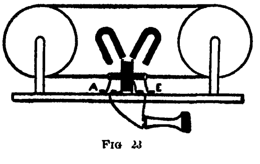

FIG 23

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[*] "Proceedings" of the Royal Society 'Note on a Magnetic Detector of Electric Waves," G. Marconi, Vol LXX 1902, page 341.

THE SEISMIC PERIOD OF 1909.

A CRITICAL CONSIDERATION OF RECENT EARTHQUAKES.

BY LIEUTENANT JOHN C. SOLEY, U. S. N.

The forces of nature are so tremendous that mankind stands impotent in the face of them, even when their operation is familiar, but after the giant forces have done their work and the world has grown quiet again the careful student may find a way to draw back the curtain from these terrible mysteries and elaborate the laws which govern the periods of activity and repose. The fundamental problem of such a line of research is to develop the causes which produce certain effects; there can be no effect without a previous cause, and no cause can act without producing its full effect. In this wonderful cosmos nothing has been left to chance. The movements of the winds in the air, of the currents in the sea and of the constellations in the heaven, the ebb and flow of the tides, all are going on with such persistent regularity that laws have been deduced which govern their operation. But these phenomena continually present themselves under different aspects; the sun rises and sets but never at the same time or place; there are alternate elevations and depressions of the sea but with a diurnal or semidiurnal variation; the winds blow strong or weak under continually changing atmospheric pressure; nature is always striving for equilibrium but the pendulum always swings back and forth. The strength or permanence of these variations always depends upon the underlying cause, and that cause is some force representing work done; but just as there is no mean force so is there no regular work done. The processes of nature which are ordinarily gentle in their operation become violent at intervals, and the seismic forces are subject to the same phases of irregularity; the rhythmic principle is always evident in volcanos, whether they are throwing out bubbles of steam or rivers of lava, and in the earth waves, whether they are pulsing gently or striking blows of titanic force. The irregularity of the movements, however, shows that the cause must be subjected to periodic influences; therefore the first step must be to group the possible causes and visible effects into periods and then by allocation, elimination or synchronism to guess at the probable cause which can rouse the unseen forces into demoniacal fury or calm them into temporary suppression.

In the year 190[illegible] solar flames and sunspots were observed on November [illegible]th and they were followed by earthquakes in Spain, Manila, Calabria and Turkestan, eruptions in Samoa and near the Cape Verde Islands.

In the year 1908 an immense sunspot was observed on September [illegible]th with auroras and sky glows, followed by earthquakes at Hilo, Vancouver, Manila, Guayaquil, Argentine, with eruptions at Kilauea and Chili, culminating in the great disaster at Messina.

In the year 1909 seismic events have occurred as follows:

January.—On the 9th and 10th nearly simultaneous earthquakes in the Canaries, northern Italy, Acapulco, near Seattle, and the cable broken [illegible] miles from Seattle. On the 20th and 21st shocks at Andalusia, Smyrna and the Ionian Isles and a great eruption in Luzon. On the 23d a violent earthquake in Southern Persia. Seismic sea waves on the coast of Northern California to British Columbia and in the North Atlantic.

February.—On the 10th eruption of Colima, earthquakes 11th in Southern France, 13th Messina, [illegible]th Asiatic Turkey, [illegible]th Portugal, Smyrna, St. Thomas, Porto Rico, Andalusia, and a coal mine explosion at New Castle, England.

March.—Violent eruption of volcanoes of Colima in Mexico and Izalco in Salvador; earthquakes few in number did little damage. 23d sunspots.

April.—Colima in eruption. 23d earthquakes Iberian Peninsula. 26th earthquakes and eruptions in the Kameruns.

May.—On the 4th Lake Erie was disturbed by pulsations causing an extraordinary rise and fall of the water at Buffalo, the water rising four feet above the normal and falling as much below. 17th earthquakes in Peru and Chili, Spain and Messina. 2[illegible]th in Iowa, Indiana, Illinois and Wisconsin.

June.—On the [illegible]th earthquakes severe at Singapore and destructive in Sumatra. 11th a violent earthquake in Southern France and the Riviera, especially disastrous in Provence, and eruption of Mount Erebus. [illegible]d shocks in Unalaska, California, Nevada and Chili; coal mine explosions in Pennsylvania. Teneriffe began to be disturbed.

July.—On the 1st shocks at California, Kingston, Caracas and Spain, with violent quakes at Messina and Reggio; on the 8th the earth waves covered a wider area and were more destructive. Shocks were felt at Kingston, Port au Prince, Lisbon, Algeria, Tunis, with seismic sea waves; great waves in the North Atlantic. 10th severe quakes in northern India and central Asia, with coal mine explosions in Russia and Spain. [illegible]th shocks in Oceania, California, Lisbon and southern Greece. The climax was reached on the 30th when the Mexican plateau was visited by a number of shocks causing much damage in Mexico city and in the cities of the State of Guerrero, which were all seriously damaged down to Acapulco, which was also visited by a great sea wave.

August.—On the 3rd shock in British Columbia, California, Brest, Lisbon and Calabria. 11th a severe earthquake in Japan through the district which was devastated by earthquake in 1891. [illegible]th quake at Acapulco with a seismic sea wave along the whole Mexican coast. [illegible]th severe shocks through northern Italy.

September.—The early part of the month was quiet except on the west coast of Mexico, where the great sea waves continued to do much damage. [illegible]th Kilauea became active. [illegible]d, [illegible]th, [illegible]th sunspots appeared in numbers. [illegible]th brilliant auroras in the north and south. On the [illegible]th a tremendous magnetic storm lasting nine hours paralyzed the cables all over the world, and it was of such intensity that earth magnets were more seriously disturbed than ever before. From the [illegible]d to the [illegible]th shocks were felt through Indiana, Illinois, Missouri and Kentucky.

October.—Early in the month shocks were felt in Utah and there was a coal mine explosion in Washington, and then the earth was comparatively quiet until the end of the month. On the [illegible]d there was another magnetic storm not as severe as the one in September, but it interfered with the operation of the Atlantic and Pacific cables and of many land lines. On the same day shocks were felt in Illinois, Missouri, Arkansas, Kentucky, Tennessee, Sicily and Beluchistan. [illegible]th an unexplained disturbance occurred in the Gulf of Mexico near Frontera which was thought to be volcanic, and at the same time a great sea wave swept in on the west coast. On the 28th there were severe shocks in northern California and southern Oregon and a great sea wave off Cape Mendocino. On the 1st there was a destructive coal mine explosion in Pennsylvania.

November.—From the 8th to the [illegible]th a tremendous storm raged through the Greater Antilles with electric storms and torrential rains. Submarine cables were affected all through that territory and there were great sea waves at many points. A volcanic eruption began on the island of Teneriffe which reached enormous proportions on the [illegible]th and suddenly ceased on the 28th when Vesuvius began to show signs of activity.

In this record certain facts stand out with striking clearness: (1) The most serious disturbances occurred between the 1st and [illegible]th, the [illegible]th and 20th, the [illegible]th and 30th of each month; the worst ones were at the end of one month or the beginning of the next. (2) The great earthquakes occurred January in Persia, April in the Kameruns, June in southern France, July in the Mexican plateau, August in Japan. ([illegible]) Volcanic eruptions occurred January in Luzon, March and April Mexico and the Kameruns, June Mount Erebus, September Kilauea, November Teneriffe. (4) Sunspots appeared in March, but they were most numerous in September, when the solar prominences were also observed with auroras; great magnetic storms occurred in September and October. (5) The west coasts of North and South America were visited by frequent sea waves, showing a general disturbance in the Basin of the Pacific. (6) The Middle West of the United States was disturbed by earthshocks in May, September and October. (7) Local earthshocks began in Teneriffe soon after the sunspots began to appear, and in November soon after the great magnetic storms the eruptions began on the western flank of the Peak of Teyde and five secondary craters opened, discharging acid lava which quickly changed to basic, and the eruption ended almost as suddenly as it commenced.

The earthquakes, the volcanic eruptions and the seismic sea waves of the last three years have all occurred at nodal points on the main line of weakness, but they were not confined to any one locality. The fact that they have occurred in so many different parts of the world at the same time indicates that some central point is the origin of the vibrations, while the synchronism between the electric storms in the sun and the magnetic storms in the earth point to a solar origin of the light rays whose penetration is so intense that they can destroy the chemical equilibrium of the magma, and whose volume is so enormous that they can flood the heavens with light at the two magnetic poles.

In the terrible cataclysms here recorded, which are caused by the titanic forces of the inner world, the same powerful agent sets the forces in motion, controls their action and quiets them again. Volcanic eruptions are not matters of chance; they are movements of the elements obeying the laws of nature. Vibrating earthwaves are no accident; they are impulses that are sent pulsing through the belt of the lithosphere under control of the same powerful laws and with the same rhythmical movement that sends the sea waves vibrating through the hydrosphere. The days, the hours are fixed throughout the universe when something shall be accomplished, as well as the rhythm by which the movements are regulated. All of these wonderful operations of nature are parts of the evolution of a period in which they bear to each other a certain definite relation.

The natural laws which govern the chemical reaction of the magma of the interior are so well known that there can be no uncertainty about the results. It is known that chlorine, fluorine, oxygen, hydrogen, silicon, carbon, sodium and sulphur can unite only in certain ways and with certain results. It is known that the lavas of which so much has been written have always the same chemical components, differing only in the proportions which make one acid and the other basic, and that sometimes the discharge of one volcano changes during an eruption from acid to basic. It is known that some volcanos emit hydrochloric, others hydrofluoric and others hydrosulphuric acid gas. It is known that the gases, the slags and the bubbling steam must result from the reactions of the magma as surely as they do in a blast furnace or in a laboratory.

Now if the natural laws are so exact in regard to the chemical reactions, they must apply with equal exactitude to the times when they shall take place. Owing to the fact that seismic disturbances are recurrent phenomena, the time factor is most important in determining their sequence; but the rhythmical movement is sometimes complicated and sometimes regulated by mechanical or chemical conditions causing alternations in the rhythm, passing from periodic to non-periodic fluctuations. We may concede that certain effects will ensue from certain causes at certain times, but there is generally an external stimulus which has a mechanical effect on the cause, resulting in rapidly changing periods. There is also possible an infinite variety in the production of vibrations due to the relative chemical intensity of the composing forces, and this phase is an important factor in determining the periods. Many of the movements which appear to be non-periodic are merely complex, and though apparently irregular it will generally be found that the components are periodic and often the entire rhythm turns out to be periodic.

From a mechanical point of view seismic movements all have a definite object in relieving the interior of the earth from the accumulated products of combustion, gas or slag, due to the chemical reactions, and this offers a logical reason for the changes from periods of rest to periods of activity. Judging by the enormous quantity of material thrown out by volcanos in eruption and by the tremendous accumulation of gases escaping at the same time, a certain amount of time must be necessary for recuperation. During this time the reactions in the magma go on under normal conditions and there is no outbreak, probably because there is plenty of room for the accumulation of gases and of slag. There are always minor explosions of gas which send tremors through the crust, and there are always the continuous volcanos relieving the pressure, but the explosions gain in force and intensity as their locus become more confined, reaching a climax when there is no longer any space inside and they must find a vent.

From a chemical point of view reasons also appear which make for periodic changes. The processes of the magma are those of decomposition or degradation to simpler forms and they involve a constant state of change, which state is followed by variations in the gas pressures. The oscillations of the high and low pressures of the interior, with corresponding changes in temperature, exercise a controlling influence on the chemical reactions which follow any changes in equilibrium. There is never an even distribution of temperature or pressure, because the properties involved are going through a continuous series of chemical changes in passing from one element to another, as the chemical activity is greatest at the beginning and end of a series, we may look for two periodic variations in each series repeating themselves at fixed intervals, but as the series of chemical changes is practically continuous, non-periodic or accidental variations may be expected of varying duration and extent.

In addition to the mechanical and chemical reasons for the periodicity, we find others by going back to the prime cause of all seismic activities, the sun. The liberation of hydrogen gas on the sun is the cause of the solar prominences and sunspots, and the liberation of hydrogen gas on the earth is the cause of the earth's eruptions and quakes. The connecting link between the two is the radio-activity of the sun, which intensifies both the electrical energy and the magnetism of the earth. Whenever or wherever the solar energy can be most directly transmitted to the earth as electrical energy, the force developed disturbs the chemical equilibrium of the magma and sets all the forces in motion. The imprisoned gases begin to explode, and the earth storms drive as violently through the crust as the hurricanes drive over the surface, while there is absolute agreement in point of time between the periods of the sunspots and the periods of active vulcanism on the earth.

A seismic period contains electric and magnetic storms, sunspots and solar prominences, earthquakes and eruptions. The first explosion of a period sets the earth waves in motion. The chemical reactions commence, the heavier minerals separated from the silicon are precipitated, and the slag permeated by the steam becomes liquid enough to flow. The hydrogen cuts its way through the channels of the old fissures.

New gas explosions send sets of waves vibrating through the crust along the lines of weakness, which reach the surface in different parts of the world almost at the same time, but far from the immediate influence of the impelling force. If volcanoes are opened in different parts of the world to throw off the slag and gases, the tension of the gases is relieved, but if there is no such relief, the gases thunder back and forth weakening the crust by their vibrations until at some point weaker than the others the crust gives way and there is a cataclysm which shocks the world. No eruption, no earthquake, is an instance of individual action; the roar of a volcano echoing over the world or the crash of an earthquake shattering a city is but the monotone of a period.

THE EVOLUTION OF THE BRAIN.*

THE ORIGIN OF NEOPALLIUM.

As the result of the investigations carried on in the Museum of the Royal College of Surgeons during the last seventy-five years by its conservators and those who have drawn their inspiration directly or indirectly from the work done in the museum, it has become possible to establish on a firm basis the criteria for instituting exact comparisons of the structure of the brain in the various groups of vertebrata.

This analytical work has now been carried far enough to justify us in attempting a synthesis of our knowledge of the evolution of the cerebral cortex. The special aim of such a research is to investigate the nature of the factors and the circumstances which have brought into being the neopallium, the part of the nervous system which, more than any other, is responsible for the kaleidoscopic manifestation of psychical activities, and the possession of which has made the Mammalia what they are, and given them the dominant position in the animal kingdom.

At the very root of the vertebrata we find that petromyzon has a cerebral hemisphere no larger than the olfactory bulb of which it is little more than an appendage. Direct nerve tracts pour smell impressions into almost every part of the surface of this hemisphere. The cerebrum at its commencement is thus almost purely an instrument for the reception and the conscious appreciation of stimuli evoked by odoriferous particles, and in the second place for providing the means whereby the physiological processes underlying this state of consciousness may affect the rest of the nervous system, and through it influence the behavior of the lamprey itself. It is just possible that even in this lowly vertebrate gustatory fibers brought up to the lobus inferior (of the forebrain) from the terminal nuclei of the seventh and ninth nerves may make their way into the primitive cerebral hemisphere, but it is still uncertain whether the lobus inferior itself may not be the place where impressions of smell and taste meet.

Even in Petromyzon there is some indication of a differentiation of the hemisphere into a superficial cortical layer (tuberculum olfactorium) and a deeper ganglionic part (corpus striatum), and there is also some slight trace at the extreme dorso-mesial edge of the presence of a small rudiment of the pallium. The tuberculum olfactorium in the Selachii assumes a definite cortex-like arrangement of cells, and is now recognizable as one of the receptive apparatus for olfactory impulses coming directly from the olfactory bulb. The corpus striatum does not receive any direct olfactory fibers; it is the part of the hemisphere which receives afferent fibers from the tuberculum olfactorium, and possibly also from more caudally situated regions of the brain—almost certainly gustatory fibers from the lobus inferior—and it emits efferent fibers which pass to the hypothalamus and indirectly influence the executive mechanisms of the body, i. e., its functions find expression in the behavior of the animal.

In some of the Selachii the dorsal part of the hemisphere is definitely transformed into a cortical area or formatio pallialis. In Petromyzon there is still room for doubt as to the existence of any such structure, but when we turn to the study of the brain in some of the sharks there can be no doubt of the existence of a considerable area of primordial pallium. There is every reason to believe that this pallial formation represents the undifferentiated rudiment of the whole pallium of the higher vertebrates. Its mesial edge ultimately becomes specialized to form the hippocampus, which in the higher vertebrata does not receive smell-impulses directly from the olfactory bulb, but indirectly through the intermediation of the olfactory peduncle and tuberculum olfactorium on the mesial side and of the pyriform on the lateral side. The lateral edge of the pallium eventually develops into the pyriform lobe, which continues to receive olfactory impressions direct from the bulb. Much later on, only in fact when the mammal appears on the scene, the pallial area intervening between the hippocampus and the pyriform lobe becomes specialized to form the neopallium. It is only right to say that this view of the nature of the primitive pallium differs fundamentally from the various interpretations now being urged by other biologists.

Putting aside the condition of affairs found in all other Ichthyopsida, the consideration of which would be confusing unless there were time to discuss their morphology in some detail, let us look for a moment at the brain of the Dipnoi. In the mud-fish the cortex-like material forming the tuberculum olfactorium becomes highly specialized and forms a relatively enormous organ upon the basal aspect of the cerebral hemisphere, of which it constitutes more than half the bulk. The pallial formation also becomes more distinctly differentiated into a cortex, the lateral part of which can now be justly termed pyriform, and the mesial hippocampal. The fornix fibers connected with the latter are embedded in a mass of ganglionic matter—the paraterminal body—which exhibits a functional relationship to the hippocampus analogous to that which the striate body presents to the other cortical areas. In other words, it is a nucleus of origin for large numbers of projection fibers which pass down to the hypothalamic region, and the cells of origin of these fibers are probably under the influence both of descending hippocampal (smell) fibers and ascending tracts from the lobus inferior of the hypothalamus (probably taste).

Leaving the Amphibia out of account, and turning at one step from the Dipnoi directly to the reptiles, it will be found that the highly developed tuberculum olfactorium of the Dipnoi has undergone a great diminution in size and an even more pronounced deterioration in structure, but the corpus striatum and the pallial formation show a great advance both in size and in specialization of structure.

There are very definite reasons for rejecting the views of Ramon y Cajal as to the homology of the mesial wall of the reptilian hemisphere, and also von Kupffer's identification of the hippocampus. Nor can we accept in its entirety the interpretation of the limits of the hippocampal formation and of its constituent parts favored by Edinger and Ariëns Kappers.

The hippocampal formation of the reptile is not broken up into two parts, fascia dentata and hippocampus *sensu stricto*, as it is in the mammal, but is a continuous column of cells, as the lecturer pointed out in 1895, an opinion since confirmed by Giuseppe Levi.

But there is no fully differentiated fascia dentata in reptiles as Levi believes. The hippocampal formation of a lizard contains cells analogous to those of the fascia dentata intermingled with others like those of the hippocampus sensu stricto, and others again intermediate in structure between the two. Thus in the reptile the hippocampal formation is caught as it were in the act of differentiating. Ultimately (in mammals) all the hippocampal cells vanish from its mesial part, leaving only "dentate" cells which form a receptive organ for incoming olfactory impulses, and the lateral (dorsal) part of the formation loses all its "dentate" cells and becomes a purely associative and projection organ.

In reptiles the larger size of the corpus striatum and pallial formation is probably related to the fact that many sensory fibers ascending from the optic thalamus make their way into the hemisphere. The researches of Edinger, Wallenberg, Gordon Holmes, Ariëns Kappers and others have made it appear most likely that these fibers carry tactile impressions from the tongue and the cutaneous areas around the mouth, and possibly also visual impulses.

These two categories of fibers are certainly abundant in the peculiarly aberrant and highly specialized brain of the bird, in which the corpus striatum takes on an enormously enhanced importance and significance, and develops along lines which diverge widely from the stream of mammalian evolution.

In the reptile there is no true neopallium, but great confusion in the relations is produced because the lateral part of the pallial formation is being suddenly stimulated to expand by the entry of these sensory and perhaps visual fibers. The rapidly overgrowing cortex becomes bent into the ventricular cavity to form a pseudo-ganglionic (but really cortical) mass which Edinger has called Epistriatum.

In the immediate ancestors of mammals the number and variety of sensory paths which found admission into the cerebrum became enormously increased and led to a further specialization of the pallial formation, resulting in the birth of the neopallium, a cortical area where all the sensory impulses brought to the cerebral hemisphere along these new channels might be received, be blended in consciousness with those coming from other sense organs, and leave impressions which might be stored, as it were, in this neopallium and so influence other sensations and states of consciousness at some subsequent time. The neopallium is thus the organ of associative memory.

It is perhaps not devoid of significance that the first appearance of a definite neopallium coincides with the transformation of the skin over the whole surface of the body into a highly specialized tactile organ.

The further evolution of the neopallium in the Mammalia and the formation of sulci and convolutions was also discussed, special stress being laid upon the value of the unrivaled collection of brains in the college museum for the study of this aspect of the subject.

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[*] Summary of Three "Arris and Gale Lectures" on "Some Problems relating to the Evolution of the Brain," delivered at the Royal College of Surgeons on December 14, 15 and 17, 1909, by Prof. G. Elliot Smith, F.R.S.

Most of our readers are doubtless familiar with what are known as Prince Rupert's drops. They are merely molten glass which has been allowed to drop into cold water and thus to cool rapidly. As a result of this sudden chilling the drops are under such great molecular strain that by breaking off the tail the entire drop is reduced to powder. The internal energy of one of these drops has recently been worked out by K. J[illegible]p. In his investigations he assumes a Rupert's drop to be spherical and the tension identical on all sides. He deduces the value 4.8 gm.-cals. as a higher limiting value for the quantity of heat stored in the drop per cu. cm. By measuring the bending moment required to break off the point of the drop when the latter is supported on an edge, the value of the coefficient of resistance to bending is found to be 40.8-77.6, the latter value approaching that for hardened steel (80). There is doubtless a connection between the extraordinary hardness of the glass drops and the internal tensions or the energy stored up. Calorimetric measurements give the mean value 0.067 (0.060-0.073) gm.-cal. per gm. of the drop for the heat evolved on breaking the drop. The specific gravity of the drops, s_1, is 2.5111 (2.5104-2.5118); that of the glass before fusion, s_0, being 2.5261 (2.5[illegible]-2.5271); the expansion $a = (s_0 - s_1)/s_1$ has the value 0.006013-0.006070. The radial pressure necessary to produce stresses equivalent to those existing in the drops is 3819.5 atmos.

Correspondence.

SQUARING NUMBERS MENTALLY

To the Editor of the SCIENTIFIC AMERICAN:

I have been for some time using a principle in squaring numbers mentally up to 1000 or more.

As this principle may be new, I shall take the liberty of submitting it by first solving a couple of problems and then explaining the principle. We will take the numbers 512 or 500 + 12 and 486 or 500 − 14.

$512^2 = (512 - 250) \times 1000 + 144 = 262,144$

$486^2 = (486 - 250) \times 1000 + 196 = 236,196$

In explanation we will let x represent the number and y the difference between the number and its nearest hundred, fifty, or whatever we wish to calculate from. Then we can form the following equation:

$512 + 12 \quad 12 \quad 12$

$(x + y)(x - y) + y^2 = x^2$ or

$\frac{1}{2}(x + y) \times 2(x - y) + y^2 = x^2$

$\frac{1}{2}(x + y) = 262, \quad 2(x - y) = 1,000, \quad y^2 = 144$

Now suppose we wish to square 56 or 50 + 6.

$56^2 = (56 - 25) \times 100 + 36 = 3136$

Let x = 56 and y = 6.

$56 + 6 \quad 6 \quad 6 \qquad 56 \quad 2$

$(x + y)(x - y) + y^2$ or $\frac{1}{2}(x + y) \times 2(x - y) + y^2$

$2 \times 50 \quad 36$

$(x - y) + y(x + y)(x - y) + y^2 = x^2 - y^2 + y^2$ which equals x^2.

Now suppose we wish to square 102: $102^2 = 102 + 2$ [illegible] $(200 - 102)$ 100 or $102 \times 100 + 4 = 10,404$.

Now suppose we wish to square 546: $546^2 = (546 - 250) \times 1000 + 46^2 = 296,000 + 2116 = (546 - 250) \times 1000 + 46^2 = 2116$. Then $546^2 = 298,116$.

This principle can also be used in extracting the square root, but not generally very advantageously. I will only give one example: $\sqrt{262,144}$. By inspection we see that the first figure of the root is 5; then by dividing by 1,000 and adding 250 we get 512 as the square root, which we know is correct, as 144, the number remaining, is the square of 12. Of course, the greater difference between the hundreds and the balance of the number, the more complicated the problem becomes.

J. J. HUTCHINS.

Defiance, Ohio.

ACCURACY OF GAS ENGINE INDICATORS

The accuracy of gas-engine indicators was investigated by Prof. Frederic W. Burstall, M. Inst. M. E., in recent comparative tests of an optical and a spring indicator. A paper describing these tests was presented at the Liverpool meeting of the Institution of Mechanical Engineers, July, 1909. A Hopkinson optical indicator and a Crosby spring indicator were connected to the two branches of a special Y-shaped fitting, so that both indicators were at the same time subjected to the pressure in the engine cylinder. The cylinder of the engine had a diameter of 16 inches, with 24-inch stroke and a speed of 16 R. P. M. Cards were taken simultaneously with four different regulations of the amount of gas admitted, giving mean effective pressures ranging from 78 to 103 pounds per square inch. Mean diagrams for each regulation were then plotted for each indicator by averaging the ordinates of twelve or more separate cards, and the mean diagrams of the two indicators for each regulation were superimposed one upon the other in order to compare them. The compression lines were found to be practically coincident within the error (1.4 pounds per square inch) of measuring and plotting the diagrams. The maximum pressures practically agreed in two of the four tests, and in the other two the Crosby indicator gave the higher indication in one and the Hopkinson in the other, the difference being about 4 per cent of the total initial pressure. On the expansion curve the two indicators agreed for the first third of the stroke, after which the Hopkinson gave a higher expansion line, resulting in mean effective pressures about 3 per cent higher than given by the Crosby. Prof. Burstall was of the opinion that neither friction nor inertia was likely to account for this persistent difference between the two expansion lines, but was inclined to attribute it to a slipping in its support of the flat bar spring of the optical indicator. His conclusions are as follows: The result of these comparisons, while not an absolute proof of the accuracy of either of the indicators, is still strong evidence that both are giving results very close to the truth.

In the optical indicator the inertia is certainly negligible; that the two give results agreeing to within 3 per cent of the mean pressure and very nearly the same figures for the initial pressure is good presumptive evidence that when either indicator is used with the precautions which have been described [The use of steel wire and phosphor-bronze stranded wire to replace indicator cord, and the use of a heavy spring to control the tension in the wire.—Ed.] the results so obtained are at least as accurate as any other measurement made in engine testing.—Engineering News.

SCIENCE NOTES

Not the least important of the works of science is its effect in the promotion of general peace. As the nations are more closely linked together by the means of transportation and communication, their interests become more nearly alike, and they do not easily plunge into wars. The applications of science to war have at the same time made it more terrible and deadly, so that nations do not dare to expose themselves to the chance of physical or commercial extermination thereby involved. If the development of the aeroplane shall make it possible for a fast cruiser like the Lusitania to be sent out equipped with rapid flying machines which, on catching the strongest battleship, shall make it possible to sail over her at too great a height to be shot at, but near enough to drop high explosives that shall destroy her, war will be at an end. The late Edward Atkinson once stated that all that was necessary to end war was the invention of a gun that should pick off generals at headquarters as the Boer sharpshooters picked off the British captains and colonels.

An English commission, which was appointed to investigate the fisheries of the North Sea, has published a report of experiments undertaken for the purpose of tracing ocean currents at great depths which have no relation to the surface currents directly above them. A very simple apparatus invented by Bidder was used. A sealed glass bottle resembling a soda water bottle, but strong enough to withstand a very great pressure, was dropped into the sea. The bottle contained sufficient air to make it float, but it was sunk by attaching to it a copper wire of weight just sufficient to overbalance its buoyancy. When the end of the wire touched the sea bottom the bottle was relieved of part of its weight and remained suspended within a few inches of the bottom. In this condition it was carried along like a balloon on a drag rope by the deep ocean current. Each bottle contained a request to the finder to return the bottle to a certain address with the date and place of finding. Twenty per cent of the bottles launched were recovered. Some were caught in fishing nets and others were stranded on the shore.

Mathematics is probably the most misunderstood of all the sciences. Huxley called it "that science which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation." To this a sufficient answer might be that she does not need to; but a better one is that it is not true. Intuition and induction have a great part in all mathematical discoveries, as all of the great mathematicians agree. Mathematics has no subject matter, but may be applied to anything that has exact relations. To sing the beauties of mathematics to those ignorant of that subject is as futile as to praise music to the tone deaf or painting to the color blind. The president of a great eastern university has said that the manipulation of mathematical symbols is a mark of no particular intellectual eminence. Presumably he had never tried it. To the often repeated charge that mathematics will turn out only what is put in, we may reply that while from incorrect assumptions it cannot get correct results, it has the power of so transforming the data as to reveal to us totally unexpected truths. Witness the magnificent generalizations of Adams and Leverrier, of Hamilton, and of Maxwell. There is no doubt that the invention of the infinitesimal calculus has furnished man with the most powerful and elegant instrument of thought ever devised.

Gulleward, Hoag and Regnier have described a method of measuring the quantity of water which escapes from the body through the lungs and the skin, and have published some preliminary results. In subsequent experiments made in Paris and again on Mount Blanc upon three persons differing in age, height and weight, they obtained results which lead to the following conclusions: The loss of weight is less at high than at low altitudes. The loss of water is also less at high altitudes, doubtless owing to the influence of cold and reduced atmospheric pressure. The proportion which the loss of water bears to the total loss of weight is always smaller on the mountain than at the sea level. Hence the increase in the number of red corpuscles in the blood which is observed at great altitudes is not merely apparent and due to loss of water from the blood. The production of new red corpuscles appears to be the means by which the organism adapts itself to the rarefied air of high mountains. A study of the diminution of the quantity of urine at great altitudes was also made. Urinary analysis revealed a great increase in the proportion of incompletely oxidised nitrogenous matter. Hence the dysury of mountain sickness appears to be the symptom of a true auto-intoxication. There is, in fact, a retention of water by the organism for the period of dysury which continues during several days, is followed by a stage of profuse urination, a veritable urinary crisis, which marks the termination of fatal cases.

TRADE NOTES AND FORMULÆ.

Water-glass Mortar.—Mix 100 parts of dried sand with 3 parts of lime which has decomposed in the air and 2 parts of powdered chalk or limestone, pass through a sieve and add 2 parts of soda water-glass solution of 33 deg. Bé.

Marking Ink for Cases and Packages.—Boil 65 parts of shellac and 65 of borax in 450 parts of water till the whole is entirely dissolved. Then add 65 parts of gum arabic and remove the boiler from the fire. As soon as the mass is cold add water to 750 parts and enough pigment until the proper consistence is reached. Lamp black will make a suitable coloring material for cases and red or white for packages. The ink should be kept in glass or earthenware vessels; no other kind are suitable for this purpose.

Coating of Electro-deposited Iron.—A fluid for this purpose can be obtained according to Varrentrapp, by dissolving 2 parts of green vitriol in 50 parts of water, mixing this solution with one of 10 parts of neutral potassio-sodic tartrate (Seignette salt) and adding 20 parts of aqueous ammonia. By using three to four Daniell's cells or a similar battery, a very beautiful coating of iron can be produced with this fluid. Or dissolve 4 parts of green vitriol and 3 parts of sal ammoniac in 40 parts of water.

Wax Varnish for Masonry.—Take 4,500 parts (4½ liters) of white Dammar varnish, 150 parts (150 grammes) white wax and 2,250 parts (2¼ liters) of turpentine oil. Carefully heat the wax in a boiler by means of steam so that it does not become brown. As soon as it is melted pour in the turpentine oil and allow to cool. When cold add the Dammar varnish. If the varnish is too bright when dry increase the quantity of wax. First prime the wall with the oil, then apply four coats of paint smooth, and finally apply the coating of varnish.

Casting for Gilding, Reissing's.—This consists of gypsum, chalk and glue, but it requires from six to eight hours to harden sufficiently to admit of being removed from the mold. Efforts have been made to overcome this disadvantage by adding alum and sugar of lead, but no appreciable results have been obtained by this means; on the other hand, a rapid hardening can be produced by using potassium sulphate, potassium bisulphate or potassium carbonate and particularly chrome alum. The same effect can be produced by lining the molds with gauze or linen steeped in a solution of the above salts.

Wax Powder.—To prepare wax powder, cut pure yellow beeswax into very thin laminæ. Spread the latter on a plate well protected from dust and leave them for eight or ten days at the ordinary temperature of a room till all moisture has dried off. The older the wax the more rapidly does it dry; a somewhat longer time therefore is needed for fresh wax. Then pulverize an equal weight of entirely dry rice starch in a porcelain grinding dish with a rough rubbing surface, gradually adding the wax chips. Care must be taken not to rub too rapidly or to press too hard while rubbing. Any portions adhering to the sides or to the pestle must be removed with a sharp spatula. All heat must be avoided; the rubbing process is best performed at a temperature of 50 to 60 deg. F. Pass the powder through a fine metal sieve and keep it in a closed glass vessel in a cool place.

Washable Drawing Paper.—This is prepared in the following manner: Take any kind of paper and lightly prime it with glue or some other binding medium adapted for the purpose, mixed with a finely powdered inorganic substance, such as zinc white, chalk, lime, heavy spar, etc., as well as with the color chosen for the paper. Then coat the paper treated in this manner with water glass mixed with a small quantity of magnesia, or dip it in the mixture and allow it to dry for about ten days at a temperature of about 77 deg. F. Such paper can be written or drawn upon with pencil, chalk, colored pencil, crayon, charcoal, India ink and lithographic chalk, and partly or entirely washed clear again twenty times or more with a wet sponge without undergoing any essential change. It makes a good substitute for school slates, etc.

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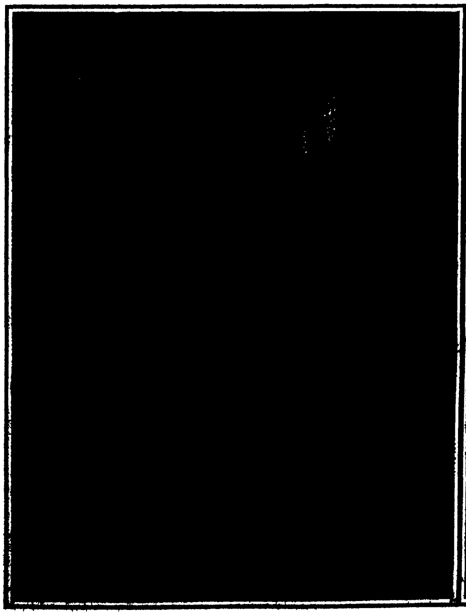
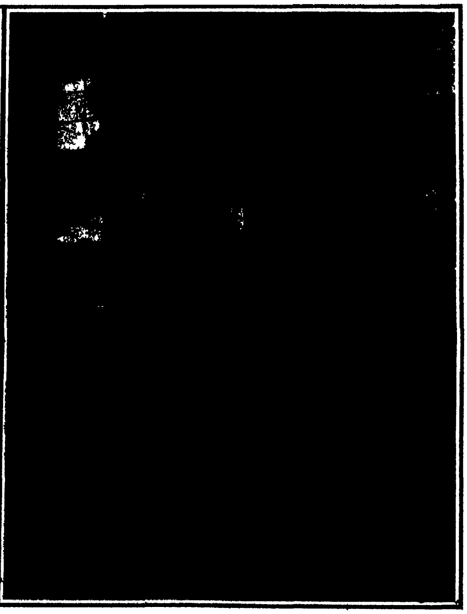
APPARATUS FOR DEMONSTRATING THE SCHÖNHERR PROCESS ON THE [illegible] LAYING FORM OF [illegible] ARCS

THE A[illegible] [illegible]



BATTERY OF FURNACES AT KRISTIANSAND



LOWER PART OF THE FURNACE.

THE SCHÖNHERR PROCESS OF REDUCING ATMOSPHERIC NITROGEN

THE REDUCTION OF ATMOSPHERIC NITROGEN.

THE SCHÖNHERR PROCESS.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN

The new process invented by Dr. Schönherr for obtaining nitrous products from atmospheric nitrogen is attracting considerable attention in Europe at present, as it appears to be an advance over the processes with which we are familiar. From a scientific standpoint it is of interest for the reason that Dr. Schönherr produces an electric arc which is very long (in some cases over 20 feet). Such an arc is especially adapted to produce nitrous oxide from the air. The nitrous oxide is then used in the preparation of fertilizers. Dr. Schönherr's process is used in a large plant recently erected in Norway at Kristianssand in order to test the system in a practical way. Here there are erected three arc furnaces of 600 horse-power each, making a total of 1,800 horse-power.

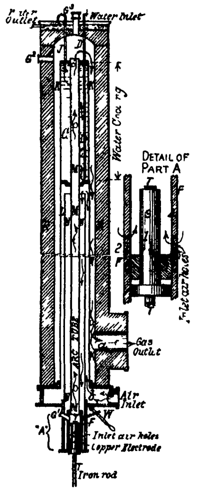
The working of this plant is now so successful that measures are being taken to operate the process on a still larger scale. The Baden Aniline and Soda Works of Ludwigshafen, who own the Schönherr process, have made an agreement with the Norwegian firm who are operating the Birkeland and Eyde process at Notodden in order to construct water-power plants to generate electricity for both processes. The enterprise includes the great Rjukan hydroelectric plant which is now building and which will use no less than 250,000 horse-power, with a total head of water of 1,800 feet. The first half of the plant will have ten turbines of 15,000 horse-power each. In addition to the electric plant there will be operated a large nitrous product plant.

The Schönherr process is based on a series of researches made at the Badische Aniline establishment. Birkeland and Eyde use an arc formed by alternating current between two electrodes, which arc is acted on by an electromagnet. By this arrangement the alternating current arc is blown by the magnet up and down alternately, so that it takes a vibratory movement and spreads out in a luminous disk as seen by the eye. The air is passed through the chamber containing the arc and is reduced to nitric oxide.

Dr. Schönherr's method differs much from this. It was thought that such arc should always burn intermittently, or if not burned continually, that it should execute rapid vibrations in the air, such as in the above-mentioned process. The inventor was however able to produce a steady arc of great length with a heavy alternating current. He forms a long arc in a tube, but were this arc not of a special character the air current sent along the tube would be apt to extinguish the arc. Mr. Schönherr devised an ingenious way of sending the air through the tube without this possibility. The air is introduced at the bottom of the tube by a set of tangential holes, so that instead of blowing straight through the tube it takes a spiral or screw-thread movement, giving a gyratory motion of the air from bottom to top. The air which thus surrounds the arc does not blow it out, but on the contrary protects it from any contact with the sides of the tube. In this way the arc burns very steadily, even though an alternating current is used, and the arc may be located inside of a narrow metal tube.

Such an arc can be seen in our engraving, which shows a demonstrating apparatus. A glass tube is used to make the arc visible. An electrode is located at the bottom and top. Piping sends an air current from below in a gyratory movement. Both these tubes have the same kind of arc burning in them. The method of starting the arc is different, however. In the left-hand tube a spiral metallic strip is placed inside the tube from bottom to top. The arc starts at the bottom and runs up along the spiral until it reaches the top, when the long arc is then formed as here observed. In order to start the small arc at the bottom of the tube a small spark gap is left between the lower electrode and the spiral band, so that the 5,000-volt alternating current can jump across the gap and start an arc. When such an arc is formed here the tension is sufficiently lowered so that there is no further passage of current at this point. After the arc has risen to the top it leaves the spiral and is now formed entirely between the bottom electrode and the upper metal head of the tube.

On the right is a similar tube which shows the method of starting the arc actually employed in the furnaces. In this case a temporary contact is made between the bottom and top electrodes by means of a fine metal wire in order to form an arc. A section of the commercial furnace is here shown. At the bottom is the main electrode, which is formed of a heavy cylinder of copper cooled by circulating water. Through the cylinder is passed a movable iron rod *T*, the upper end of which is used as the actual electrode for the arc, so that this rod alone is worn by use. The wear is very slight and is inappreciable in a commercial plant. The iron rod is pushed up by hand from time to time in order to take up the wear. Under the action of the arc the iron is covered with a layer of magnetic oxide of iron in the fused state, and this is volatilized but slowly, for which reason there is no excessive burning of the iron. To start the arc in the first place the lever *W* is thrown, which brings a metal rod temporarily in contact with the electrode. The arc then mounts up along the side of the metal tube *W* surrounding the interior, and thus reaches the top. Air is admitted at the bottom through a set of tangential openings *F* in the tube, which openings can be partially shut off by means of the sliding collar 3 so as to control the air flow. When the air enters by a single opening it passes up the tube in a screw-thread form, which causes the arc to be somewhat deviated laterally. This effect will be seen in the demonstration tube. The arc has a distinctly undulating form. In practice there are used a number of similar openings so as to give a very regular gyratory movement to the air, and the air current is better in this case. Observation shows that there is now no deformation of the arc, and that it follows a straight line through the tube.



SECTION THROUGH A SCHÖNHERR FURNACE.

In the furnaces used at the Kristianssand plant, which we illustrate here, the arc has a length of 16 feet for the 600 horse-power furnace, and for the more recent 1,000-horse-power type it has a length of less than 22 feet. The upper electrode is formed by the sides of the metal tube itself, the surrounding tube being seen at *MM*. Such an arc can reach the top of the tube, or in other cases it is formed near it at a point where the gases are very highly heated and become conducting to some extent, so that the current can now pass across. By means of the eye pieces G_1 at the bottom and G_2 and G_3 at the top we can observe the working of the arc. Around the upper end of the arc tube is a cooling chamber *cc* by which the hot gases are suddenly cooled down to a much lower point. This quick cooling is essential for the good production of the nitric oxide. Water circulation is given at *D* and *J*. After leaving the upper end of the arc tube the heated gases pass down in a concentric space *KA* inside the masonry of the furnace and pass down into the gas outlet *a*.

The fresh air enters the furnace at the lower inlet pipe *b* and first passes up through the concentric space *L*, it being heated in its passage by the gases which are leaving the furnace. At the top it changes its course and redescends through the other concentric space *N*, passing along the outside of the arc tube, so that it is further heated. Thus when it finally enters the tangential openings *f* of the arc tube it is already well heated, and this furthers the action within the arc tube.

The gases leaving the furnace consist of air and about 3 per cent of nitric oxide, such percentage, seemingly low, being in fact one of the highest yet obtained. Such hot gases are then passed through the tubes of a boiler in order to furnish steam for use in concentrating the nitrous products by evaporation. The nitric oxide changes to the reddish-brown nitrous oxide when cooled to 600 to 140 deg. C. To prepare the nitrates the gas is absorbed by soda or lime in suspension. By using lime there is formed a nitrate of lime which has a greater proportion of nitrogen than usual, and contains 18 per cent, while Chili saltpeter has but 15 per cent and the Notodden product 13 per cent. The new product is therefore superior as a fertilizer.

RADIUM AND CANCER.

The Revue générale des Sciences of November 30th contains a lengthy and important article by Dr. Louis Wickham on the therapeutic action of radium on cancer, based upon observations made on 1,200 patients suffering from tumors, half of which are stated to have been malignant. Dr. Wickham himself has demonstrated recently in London and in Belfast the nature of the results he has obtained, and full reports are available in the Proceedings of the Royal Society of Medicine and in the British Medical Journal. Therefore there is no need to reproduce the details of the article. The illustrations in the Revue générale des Sciences are even more startling than those which have appeared in the English journals cited. The appearances presented before and after treatment are such as will almost surely carry conviction to all laymen, whether healthy or suffering from cancer, that radium can cure the disease. But Dr. Wickham does not write in a corresponding spirit of optimism. Indeed the only note of triumph is the phrase: It is delightful to think that the whole evolution of radiotherapy (the marvelous discovery of radium by P. Curie and Mme. Curie, the construction of perfected apparatus, therapeutical applications) is almost entirely French. No one may grudge this full measure of recognition to the advances made possible in Paris on the biological action of radium by collaboration between laboratories of physics, chemistry, and pathology. Not the least measure of praise is due to Dr. Wickham himself, both for his initiative and for his achievements.

Persons who possess an intimate knowledge of the clinical course and pathology of cancer will be less impressed by the pictures of cured cases than by what Dr. Wickham writes and what he omits to refer to. The evidence of diagnosis and of microscopical structure is imperfect. The duration of the period of benefit after treatment, as well as the ultimate fate of the patients, are the criteria by which the success of surgery is measured, but the evidence advanced in Paris falls short of good standards in both respects. Dr. Wickham lays no claim to successful treatment of secondary deposits, he says severe cases ought only to be treated when the surgeon can do nothing, and that it is too early yet to say if radium is the means which ought always to be employed. A warning is given of the necessity for caution in appraising the value of any new treatment, and above all of the necessity of avoiding the risk of depriving patients of other treatment which has proved itself superior, especially of surgery.

The results obtained in Paris have attracted the attention of the world. The hopes they have aroused have awakened yet greater expectations for the future, when larger quantities of radium shall be available, and the technique better mastered. Meantime, notwithstanding Dr. Wickham's caution the writer considers a further note of warning is necessary. All that is claimed for radium is a beneficial action when applied directly to primary growths. Secondary growths inaccessible to direct surgical removal are inaccessible to radium in consequence of the restricted penetration of the rays. Whether or not means will be devised for attacking deep secondary deposits—the very site of which it may be impossible to determine—remains to be seen. The actual injection of emanation solution has met with no success. Nor is the evidence that radium has a marked elective action for cancer tissue so strong at present as to arouse any great hopes from more efficacious means of flooding the body with radio-activity. In short radium does not appear to be nature's remedy for cancer but an empirical remedy with the same shortcomings as all other such in the case of cancer in that the local condition alone is attacked and the constitutional conditions are unassailable.

That the body can generate powers of its own leading to constitutional changes which enable it to deal effectively with cancer has been abundantly demonstrated by recent experiment. In given circumstances 100 per cent of animals bearing transplanted tumors can cure themselves. The facts ascertained show that the natural forces of the body can cope both with secondary deposits and with primary growths. Though this process of natural cure is not and may not speedily be elucidated still it is not too sanguine an expectation to anticipate that ultimately it will be. The means for checking the ravages of cancer will be found, not by searching the surface of the earth for a vegetable remedy nor the bowels of the earth for a mineral one but by following the definite clue that in the living body itself forces can be elicited which effectively combat the disease. Until that goal shall be attained when surgery fails or is unavailable relief may be sought but cannot be guaranteed by resorting to treatment with radium the full possibilities of which have not yet been developed even in Paris—Nature

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THE CHEMISTRY OF INSANITY.

A CURIOUS THEORY.

Among the present wonders of science none stirs the imagination says The British Medical Journal so powerfully as the doctrine that some forms of insanity are the result of a chemical change in the blood. The ill temper which we feel and make others feel on a bleak east windy day or from want of sleep or because our digestions are out of order and every stage of drink from the happy letting free of thought and talk to the reeling home and physical nastiness of the drunkard and all the nightmares all attacks of melancholy all extravagances of passion—they are all due to a chemical change in the blood acting on the brain.

But go even further back we are bidden think of such cases as most of us at one time or another have known or have watched or have been. Here is a case of typhoid fever and with other evidence of a change in the blood such as a high temperature a rash pains in the bones and the like comes delirium and the patient babbles or raves.

Here is a case of influenza the acute stage is past but the patient is so odd so dismal worrying over his business though he need not worry and always saying that he ought to have done more for his wife and the children and then one day he is lost and found dead by his own hand. Go further here is a case of chronic alcoholism here a case of puerperal mania here a case of mania after some terrible shock. Chemistry chemistry all of them chemistry! Do we not brew within ourselves poisons which enter the circulation and pervade every tissue of the body? What is the difference between a man talking nonsense under the influence of wine or the influence of an anesthetic and a man talking nonsense under the influence of the poison the toxins of typhoid fever? Or take the instance of temporary insanity after shock. Do we not all know from experience how sudden terror sudden bereavement sudden happiness can upset the functions of the body in a chemical way just as poisonous food upsets them and shall the brain escape and not be upset with the rest of the body?

This doctrine sweeps into its net a whole legion of cases. Other cases at present are outside the net. Cases where the whole life has been careful temperate chaste and uneventful. Cases where heredity and that alone seems to have done the harm. Cases for there are some fools who think of them as cases of genius. Never mind at present what at present escapes the net. See what is taken in it. Was there ever such a haul?

Nobody can doubt for a moment that the doctrine of a chemical agent in many forms of insanity a poison or poisons a toxin or toxins brewed within the body has tight hold of truth. Nobody can doubt either that the treatment of some cases of insanity is likely now or in the near future to be advanced by work done on the lines of this doctrine and on these lines alone.

As a matter of fact this chemical explanation of insanity is not so new as it sounds. The substance of the doctrine may be found in old medical books with their strange talk about gross and peccant humors troubling the vital spirits. But for exacter knowledge the doctors had to wait for exacter methods. They could not formulate a chemical theory of insanity without the help of physiological chemistry they could not formulate the chemistry of fever without the help of bacteriology and for bacteriology they had to wait first for better microscopes and then for Pasteur. In every age the doctors have been as far forward as the age would let them go and no opportunity was given them until now to advance to the ground which they are now beginning to hold.

But a special charge is laid against them in this matter. It is said that they have been many of them, all along, on the same track, a wrong track. They have believed in mind as something wholly different from brain. They have clung to an old faith which is alien to science and has lost all influence over many schools of modern thought, that a man is not only a corporeal being but also a spiritual being—free and in some way independent of his physical structure. All their ideas about insanity have been clouded and confused and blocked by this purely conventional notion of mind or self as real.

All along they have talked and written of insanity as a disease of the mind not as a disease of the brain and have treated it in the old days with chains and strait waistcoats in later days with kindness and recreations but never with chemistry. If only they had started thirty years ago with the plain truth that the brain secretes thought just as the liver secretes bile what an infinite gift might now be in their hands what a burden lifted from the world. If only they had worked at insanity as they have worked at diphtheria and myxedema should we not have by this time an antitoxin or a tabloid of some organic extract a sure and rapid cure. But they failed to grasp this simple fact that thoughts are merely the results of molecular changes in the gray matter of the brain.

Now it is true that the doctors many of them have sinned in this way and most that can be said to excuse them is this that they have sinned in very good company. They are opposed to the present tyranny of popular materialism. Let us see why. Popular materialism roughly speaking is the creed that free will self spiritual life and all such words are merely the names of mental processes and that mental processes are merely the results of cerebral processes. Whence it follows that if only one could get at the cerebral processes get at them with exactitude by drugs or by hypnotism or by surgery one would get at the corresponding mental processes.

The old-fashioned doctor says When we doctors can do that do it with exactitude do it with safety to the patient and do it with a successful result I shall be no less pleased than surprised. Or to speak more accurately I shall be in my grave long before that and the pleasure and the surprise will come to doctors then living. Meanwhile I must do my best with what resources I have. And I say this that I in my family practice would be hindered more than helped if I took the position of cocksure materialism.

For one case of insanity the doctor sees twenty cases of those who are sane yet betray some fault some little instability temporary or permanent of the nervous system. They are sane but each of them has at times or always his or her failing a sort of faint image or haunting sense of some weakness which nursed and fed up and stimulated might grow to a dreadful size. Look at these cases if they can be called cases this multitude of men and women going about the day's work and the day's pleasuring sane useful members of society but none of them up to the mark. Then from them look onward to those cases so terribly common at the present time the legion of women with some men among them nearer the edge of danger those whom the doctor used to call hysterical but now calls neurotic but who call themselves by a host of pretty names delicate overworked dreadfully sensitive. Then look onward to the very danger edge to the borderland cases the poor folk who are just so insane that they cannot still be counted as sane. Then and not till then look over the edge.

The doctor surveying this long crowd of his fellow creatures and conscious doubtless that he is no mere spectator but has a place himself somewhere in the line sees no break anywhere no sudden gap between perfect sanity and absolute insanity. It is evident that the doctrine of a chemical agent at work in some cases of insanity will not help the doctor here. He does not possess and never will a graduated series of antitoxins to treat all these people. A doctor running about with an antitoxin syringe to cure ill temper little eccentricities and slight attacks of the blues would be a monster whom the State ought to catch and keep out of the way. You must be your own doctor. That is his message. You must cure yourself. No wonder that the doctor is a bit of a priest for here is the old sermon that the will must be exercised.

To the vast multitude of neurotic women a word or two may humbly be said here to induce them to see themselves as the doctor sees them. First they must not think that the neurotic temperament is in any way an evidence of cleverness or of good breeding or of culture. Whatever it may be it is not that. Nervousness is in no sense one of the accomplishments of the real lady. It never was and it never will be. Indeed it is going the other way. Fifty years ago a woman might be neurotic and still be a lady. Now the doctor finds neurotic women mostly in the humble walks of life among his patients at the hospital or at the dispensary even more often than in fashionable circles.

Next they must abhor as the very devil all secret use of drugs or of stimulants. Once started on that disastrous course they will go as a dead certainty from bad to worse.

Next they must remember that they are spoiling their people's lives as well as their own. A neurotic woman is a bore.

What can she gain by her neurotic temperament? She has but one life. It might have been so much happier. The doctor does indeed pity her but he has no antitoxin for her.

There is to be sure concludes our contemporary one antitoxin. She must brew it within herself. It is a spiritual product not chemical. To brew it many people have recourse to spiritual methods unknown to science. This heavenly antitoxin is what we call the power of the will.

HYDROGEN FOR BALLOONS

The recent development of aeronautics has suddenly created a demand for large quantities of hydrogen at a low price. For supplying this demand France is at present laboring under great disadvantages in comparison with Germany and even with Italy. In most cases the French military balloons are necessarily filled with hydrogen obtained by the old zinc and sulphuric acid process and French aeronauts who purchase hydrogen are compelled to pay twice the price which this gas commands in Germany where it is produced in great quantities as a by-product of the manufacture of soda by electrolysis. France possesses only one electrolytic soda works but it is expected that the Claude process of producing hydrogen will soon be in practical operation. This process of fractional condensation was first applied to air the product being pure nitrogen highly oxygenated air and liquid oxygen. By applying the process to the impure mixture of hydrogen and carbon monoxide which is known as water gas and employing liquid air as a refrigerant it is possible to separate and even to liquefy the hydrogen of the mixture. When developed on a practical scale the Claude process should furnish a cheap and copious supply of hydrogen which could be compressed and transported in steel cylinders.

In regard to the manufacture of liquid hydrogen which has been erroneously announced as being in commercial operation it should be borne in mind that the necessity of employing intense cold will always make liquid hydrogen very costly. The employment of liquid hydrogen should therefore be restricted to small quantities for use in emergencies.

Liquid hydrogen occupies only 1/800th the volume of the same quantity of gaseous hydrogen at the standard pressure and temperature and it can be vaporized conveniently and as rapidly or slowly as may be required by the admission of measured quantities of air which will liquefy and cause the evaporation of corresponding quantities of hydrogen. But in addition to the cost of liquid hydrogen which will always be high (except possibly in some districts abundantly provided with water power) there is the very delicate problem of transportation which requires the employment of double-walled metallic vessels and the maintenance of conditions which are difficult to realize in practice.

Hydrogen can also be obtained from water gas by another process in which the other ingredients of the mixture (carbon monoxide carbon dioxide and nitrogen) are absorbed by calcium carbide at a moderately elevated temperature. This process according to its inventor is quite practical and furnishes a gas containing 99 per cent of hydrogen with traces of nitrogen and methane.—La Nature

TALKING ELECTRICITY.

SPEAKING MAGNETS, SPEAKING IRON, SPEAKING WIRE.

BY EMIL KOSACK.

Nearly half a century has elapsed since Philipp Reis first exhibited his apparatus for the electrical transmission of sound, to which he gave the name telephone. By means of this apparatus, which comprised a transmitter and a receiver, songs and instrumental music could be transmitted satisfactorily, but for the transmission of speech it required fundamental improvements, which were first developed chiefly in America and first assumed practical form in the Bell telephone. This instrument consists of a steel bar magnet, bearing at one end a small coil of wire, and an iron membrane stretched closely above the coil bearing pole. When the coil is traversed by an electric current of rapidly fluctuating intensity, corresponding variations in the strength of the magnet and its attraction for the iron membrane are produced, so that the membrane is set into vibrations which generate sound waves in the air, and produce audible tones.

Another important stage in the development of the telephone is marked by the invention of the microphone, which is now employed universally as a telephonic transmitter. The essential part of the microphone is an electrical connection of varying resistance, formed by the loose contact of pieces of carbon, inserted in the circuit of a few galvanic cells. The resistance of the contact and, consequently, the strength of the electric current vary with the force with which the carbon surfaces are pressed together, and this force is sufficiently affected by the fluctuations of air pressure produced by speaking into the instrument to cause variations in the current, which correspond in every detail to the vibrations of the vocal sounds. Hence, if a Bell telephone is inserted in the same circuit its membrane is forced to vibrate in a corresponding manner, and thus to reproduce the words spoken into the microphone.

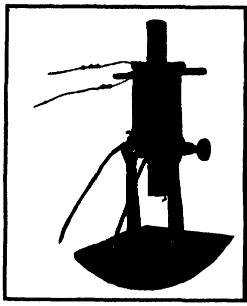


FIG. 1. SPEAKING ELECTRO MAGNET.

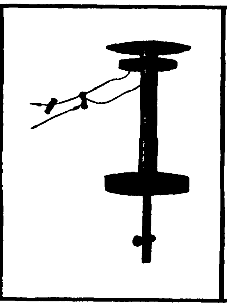


FIG. 2.—SPEAKING BAR OF IRON WITH SOUNDING BOARD.

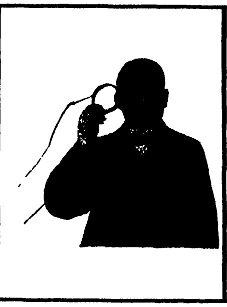


FIG. 3. SPEAKING COIL OF WIRE.

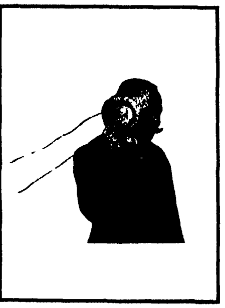


FIG. 4.—SPEAKING COIL OF WIRE WITH SOUNDING BOARD.

In what follows we shall confine our attention to the receiving apparatus. The Bell telephone, in improved form, still remains almost the only practical telephonic receiver. In recent years, however, several other methods of translating the currents of the microphone into sound have been discovered. In 1898 Simon found that an electric lamp will reproduce words spoken into a microphone, if the vibratory microphone current is superimposed upon the uniform direct current which normally operates the lamp. This phenomenon is explained by the variations in the temperature of the arc, which are produced by the microphone current and which are sufficient to cause vibrations in the surrounding air, which are perceived as sound. The microphone current is impressed upon the arc, not directly, but indirectly, by means of a small induction coil, or transformer, consisting of an iron core surrounded by two coils of insulated wire. One of these coils is inserted in the circuit of the microphone, the other in the circuit of the lamp. The fluctuating microphone current in the first coil generates, by induction, a similarly fluctuating current in the second coil, connected with the lamp.

Several experimenters with this apparatus observed that the telephonic reproduction of sounds sometimes took place when no luminous arc was formed, and traced the sounds to the transformer. The writer discovered that even the hissing sound which is occasionally produced by arc lamps was clearly audible in the transformer, placed in another room. As a transformer is essentially an electromagnet, it follows that every electromagnet and every permanent magnet can be made to sing and speak under the influence of a vibratory microphone current, which causes periodic changes in the magnetization of the iron or steel and thus produces molecular vibrations which generate sound waves in the surrounding air.

Peukert found that even the large masses of iron contained in dynamos can be thrown into audible vibration by the weak currents of the microphone, and constructed a telephonic receiver consisting merely of a closed horseshoe magnet, encircled at one point by a coil of wire connected with the microphone. The form of "speaking magnet" used in the writer's experiments is shown in Fig. 1. It is a straight bar electromagnet, energized by a direct current, but carrying also a small coil connected with a microphone.

The writer found, furthermore, that the magnet could be replaced by a simple core of ordinary unmagnetized iron. This change greatly weakens the action which, however, is greatly intensified by laying a thin plate of any material on the upper end of the core, as shown in Fig. 2. The plate takes part in the vibration and enables a roomful of persons to hear music played or sung before the microphone at the other end of the line. In this experiment the entire absence of the disagreeable crackling noises produced by the ordinary telephone was especially striking. This form of apparatus shows a certain resemblance to the old Reis telephone in which, however, the iron is not in the form of a heavy bar, but in that of a thin wire, which is attached to a resonance chamber. From all these experiments it appears that a telephonic receiver can be constructed in the most primitive manner by inserting almost any coil of wire in the microphone circuit, slipping the coil over a hammer or other piece of iron, and attaching a plate of any material to the iron. Hence the iron membrane or vibrating plate of the Bell telephone is entirely superfluous. The writer has found by experiment that the construction can be still further simplified to a surprising degree. It is only necessary to apply to the ear a coil of wire connected with the microphone in order to hear faintly the sounds by which the microphone is operated (Fig. 3). Such a coil, consisting of a few yards of insulated copper or iron wire, is certainly the simplest form of telephonic receiver, but to give the instrument any practical value it is necessary to attach to the coil a plate of iron, brass or other metal, as is shown in Fig. 4. The metal plate intensifies the sound so greatly that when the instrument is applied to the ear words softly whispered into the microphone are distinctly audible. This apparatus differs from all forms of telephonic receiver now in use by the peculiarity that no iron need be used in its construction.

The action of this new telephonic receiver is explained by the well-known law of attraction between two parallel conductors traversed by electric currents flowing in the same direction. The individual windings of a coil of wire may be regarded as so many parallel conductors, which attract each other with a force which depends upon the strength of the microphone current which flows through them. As the fluctuations of this current correspond to the vibrations of the sound waves which act on the microphone, entirely similar vibrations are produced in the wire coil of the receiver and transmitted to the surrounding air, as sound waves, through the agency of the broad plate attached to the coil.—Translated for Scientific American Supplement from Umschau.

THE MEAN HEIGHT OF THE ANTARCTIC CONTINENT.

Prof. W. Meinardus gives the results of an estimate of the mean elevation of the central core of the Antarctic land mass, based on the distribution of atmospheric pressure and consequent exchange of air between the two hemispheres, in the November and December numbers of Petermann's Mitteilungen. Extending Spitaler's results with the help of Mohn's discussion of the "Fram" observations, and Baschin's maps of the southern oceans, Prof. Meinardus finds that, while the mean pressure (not reduced to sea level) is 0.85 millimeter higher in January than in July between latitudes 0 deg. to 80 deg. N., in the zone 0 deg. to 50 deg. S. it is 2.14 millimeters lower. In higher southern latitudes, as far as 60 deg. S. lat., the January pressure is 0.73 millimeter less than the July, and from 60 deg. S. to the Antarctic circle the relation is almost one of equality. Hence, allowing for proportional areas, it follows that within the Antarctic circle the true atmospheric pressure must be 11 millimeters higher in January than in July.

Observation however has so far failed to reveal the existence of this excess; the diminution of the southward temperature gradient and consequent weakening of easterly winds on the edge of Antarctica in summer render it probable that, as in the north polar region, the pressure at sea-level is actually lower in summer than in winter. The discrepancy can be explained by assuming a mean elevation for the area within the Antarctic circle, and taking —3 deg. and —26 deg. as the mean temperatures for January and July respectively, Prof. Meinardus gets a value for this of 1,328 meters, or, as a second approximation with temperatures —6 deg. and —29 deg., 1,350 meters, with a probable error of ± 150 meters. Having regard to the proportion of the area known to be covered by sea, the land surface is taken as 14 millions of square kilometers (Bruce and Krümmel), and its mean height then becomes 2,000 meters, with a probable error of ± 200 meters.

Recent explorations suggest that this value is not far from the truth, the covering of inland ice being, as in Greenland, an important factor. If it is approximately correct, Antarctica is the largest mass of raised land in the world; it is half as large again as Europe, and Asia, the highest of the known continents, has a mean elevation of less than half (950 meters). The accepted value of the mean height of the land surface of the world, 700 meters, is raised to 825 meters, and the mean level of the physical surface of the globe from 205 to 240 meters.—Nature.

A fuel-testing plant is being established by the Canadian government for investigating the natural fuel supplies of the Dominion. As peat occurs in immense quantities in both Ontario and Quebec, an attempt is to be made to discover a method of using it successfully in gas-producers.

H. M. S. "LION."

HER PROBABLE APPEARANCE WHEN COMPLETE

We venture to give an illustration of the Lion as she will appear when complete if the published accounts are right This vessel will be by far the most notable war vessel in the world She will be about 700 feet long between perpendiculars and 8[illegible] feet 6 inches in beam She will displace about 26 500 tons and will be propelled by turbines of 70 000 shaft horsepower Her speed will be probably not far short of 30 knots Her armament will following the all big gun principle consist of eight 12 inch guns in four barbettes and all will be placed on the center line As her secondary armament she will probably carry sixteen 4 inch guns On the whole she will probably be the most powerful vessel afloat when completed

Unlike the Orion the Lion will probably have two tripod masts and in view of the fact that she carries no less than forty two boilers which have to burn coal enough to develop 70 000 horse power we have shown her with four funnels It may be recalled in support of this that the Mauretania and her sister of approximately the same power have each four funnels and that the Invincibles which develop only 40 000 horse power have three Hence even with four funnels if the same cross sectional area per unit is allowed the Lion would be under funneled There is moreover the fact that the use of four uptakes permits a more convenient arrangement of the boiler rooms and finally that there is room for the four The only argument against them is increased target area but four funnels have been frequently employed in cruisers and even six —Engineer

HIS MAJESTY S FIRST CLASS CRUISER LION —A FORECAST

EXPERIMENTAL BOMBARDMENT OF THE "JENA."

THE RESULTS OF THE FRENCH FIRING TESTS

Since the experimental bombardment of the Belle Isle of the British navy at the commencement of the present century no such thorough and systematic firing tests have been directed against a warship in any foreign navy as those of which the French warship Jena was the target last year The numerous accidents which have befallen the French naval artillery in recent years and in particular the unsatisfactory behavior of the ammunition when stored on board and in the firing tests of 1907 8 had seriously impaired the confidence of French naval officers in the efficiency and reliability of their chief weapon A divergence of opinion in regard to projectiles had furthermore been created by the results of the Russo Japanese war The Semenoff school demanded even of the projectiles of the heaviest guns an explosive action similar to that of the celebrated Japanese shells which wrought such havoc at Tsushima while their opponents attached the chief importance to armor piercing power combined with the maximum explosive action that is consistent with great penetration Hence a searching investigation appeared requisite in order to restore confidence and to avoid mistakes in the ammunition of new war ships The Jena which had been seriously injured by an explosion in 1907 and was unfit for further service was selected as the object of attack

Despite the strict secrecy which the French navy has maintained in regard to the methods and results of the experiment an approximate idea of the firing tests can be obtained from reports published in the French and English press

The original intention was to begin the attack with non-explosive armor piercing shells fired from a distance of 8 miles or more but the Chamber of Deputies made this impossible by striking off $10 000 from the appropriation of $120 000 which the Senate had voted for the experiments An unusually great practical value is given to these firing tests by the fact that the object of attack was a comparatively modern warship The Jena was launched in 1898 Her displacement is 12 100 metric tons Her armor includes a water line belt of Creusot cementation steel varying in thickness from 12 6 inches amidships to 9 1 inches at the bow and stern an upper belt 7 feet high and from 3 1 to 4 7 inches thick extending from the bow to within 100 feet of the stern casemate armor 3 5 and 4 inches thick, a 2 6 inch protective deck commander's turret 11 7 inches great gun turrets 11 5 inches and communicating galleries 8 inches thick Her former armament comprised four 12 inch guns mounted in turrets eight 6 7 inch rapid fire guns protected by 4 inch shields in casemates separated by 1 2 inch partitions eight 4 inch rapid fire guns with 2 2 inch shields and twenty 1 8 inch rapid fire guns This armament had been removed but an obsolete heavy gun was placed in each turret and an old 6 5 inch gun in each casemate The explosion in 1907 had injured the after part of the vessel and affected its flotation The latter defect was remedied by filling some of the compartments with cork and the ship was brought to her normal water line by the addition of ballast The firing tests were confined to the forward and middle parts Some of the casemates contained the regular supply of ammunition The German apparatus for controlling vessel and gun fire was in place The lighting system as well as the apparatus for ventilation to which particular attention was to be given on account of the danger from smoke and gas in battle were in partial operation Puppets representing men were distributed about the vessel and dogs pigeons and rabbits were placed in the turrets and casemates and in unprotected situations At first microphones were attached to some of these animals for the purpose of determining the effect produced on the action of the heart by explosions of shells but the results obtained were so meager that the instruments were soon removed The boats were left in their places and the bunkers of the part of the ship to which the attack was confined were filled with coal Preparations were made for testing the utility of light armor around the smokestacks The effect of shots on fireproofed wood the combustibility of paints t

The vessels detailed for the firing tests were the warship Suffren and the armored cruisers Condé and Latouche Tréville The firing at long range with which the experiments concluded was done by the Suffren and the armored cruiser Jules Michelet These vessels carried guns of the following calibers and types

Caliber Inches	Length Calibers	Model Date	Vessel	Muzzle Velocity Feet per Second
12	40	1893 6	Suffren	2 673
7 6	50	1903	Jules Michelet	3 1[illegible]8
7 6	45	1893 6	Condé	2 75[illegible]
7 6	45	1887	Latouche Tréville	2 52[illegible]
6 4	50	1902	Jules Michelet	3 116
6 4	45	1893 6	Suffren Condé	2 837
5 4	45	1887	Latouche Tréville	2 509
3 9	55	1892	Suffren Condé	2 [illegible]4

All of these except the 12 inch are rapid fire guns

The 9 4 inch 50-caliber gun model 1902 6 provided for ships of the Danton class was represented by a 9 4-inch 40 caliber gun model 1893 (muzzle velocity 2 624 feet per second) mounted on a neighboring islet on which were installed also for the experiments of the war department a 9 4 inch 28½ caliber gun model 1881 (muzzle velocity 2 034 feet per second) for the discharge of the heavier [illegible] shells of the coast artillery and a battery of 6 4 inch guns

The following shells were provided for the firing tests 18 12 inch 7[illegible] [illegible]4 inch 1[illegible] [illegible] inch 106 6 4 inch 3[illegible] [illegible] inch and 3 [illegible]4 inch [illegible] shells All of these except the [illegible] shells were made and charged specially at the Gavres arsenal In the long range firing which concluded the experiments shells taken from the magazines of the Suffren and the Jules Michelet were used but as a precaution against accident 40 similar shells were first discharged at the Gavres proving grounds

As was mentioned above the solution of the problem of ammunition was the principal object of the whole experiment It had been decided to abandon the use of cast iron shells (*obus [illegible] fonte*) Cast iron shells charged with black powder had already been abandoned and the cast iron shells charged with melinite which constituted a large part of the ammunition of the older vessels were regarded as unreliable on account of the weakness of the wall of the shell and the resultant danger of bursting the gun Steel shells of two types were in use armor piercing shells (*obus [illegible] rupture*) charged either with black powder or with [illegible] or 3 per cent of their weight of melinite and semi armor piercing shells (*obus [illegible] s mi rupture*) charged with about 6 per cent of melinite

The events of the Russo-Japanese war led to an agitation in favor of increasing the charge of high explosive to 10 or if possible [illegible] or [illegible]0 per cent of the weight of the projectile even though this change should necessitate a considerable diminution of initial velocity The naval administration however insisted on the necessity of high muzzle velocity in view of the steady increase in range and therefore regarded an increase of explosive charge which involves a decrease in the thickness and strength of the shell as impracticable The administration also considered the chief function of heavy guns to be the penetration of armor and the destruction of the vital parts of the ship inside the armor The explosive charge was calculated in accordance with these views and was fixed for the new shells at 3 per cent of their weight while an absolute increase of the charge was effected by increasing the weight of the shell by about one third Thus was evolved the new standard shell (*obus alourdi*) for ships of the Danton class which is [illegible] calibers long and is charged with 3 per cent of melinite The new 12 inch shell weighs 968 pounds and contains 29 pounds of melinite (instead of the [illegible]48 pounds weight and 19 pounds charge formerly employed) the new [illegible] 4 inch shell weighs 484 pounds and contains 14 3 pounds of melinite

Another new projectile constructed as an experiment is an elongated 6 4 inch steel shell (*obus alourdi*) having a length of [illegible] calibers and a 10 per cent charge of melinite The war department has gone still farther in this direction by supplying the 9 4 inch coast defense guns with the *obus P* charged with 75 pounds, or 17 per cent of its weight, of cresyt. This shell is designed to be discharged with a low initial velocity (1,800 to 2,000 feet per second) against the parts below the water line. Former firing tests had caused it to be regarded as unfit for naval ammunition, because of the low initial velocity necessitated by the high charge of explosive.

Shells of all the types described above except cast iron shells charged with melinite appear to have been discharged against the "Jena." They were ignited by retardation exploders, of various French and foreign makes which were placed at the base of the projectile and operated by its rotation. The new Watson contact exploder, designed to operate on striking 1/6-inch plates, was used with some of the highly charged elongated and "P" shells.

The firing tests were conducted contrary to the original plan, chiefly at very short range, although five 12 inch and twenty smaller shells were finally discharged at long range. In general, the attacking vessel was anchored from 1,600 to 2,000 feet distant from the "Jena," and the firing charge was calculated to give the shell the same final velocity which would have been produced by a full charge at the distance of 20 000 feet, the long range mentioned above. As it was desired to hit, in each case, a predetermined small part of the ship, the greatest possible care was taken in aiming. In consequence of this, of the elaborate examinations made, and the numerous precautions observed, only from two to four shots were usually fired in a day. After aiming, the gunners abandoned the turret or casemate, and the gun was discharged electrically from a neighboring turret. The ship's company remained beneath the protective deck, the ammunition chambers were closed and the firing piece was completely isolated from the ammunition hoist and the magazine. Similar precautions were observed in the discharge of the "P" shells by the land battery.

Each shell was photographed as it left the gun and as it struck the "Jena," and after each shot a new diagram of the "Jena" was made, on which each hit was marked in white, red or green, according to the size of the shell.

The first series of experiments was conducted in August and September by the armored cruisers "Condé" and "Latouche Tréville," with 7 6, 6 4 and 3 9 inch shells of which only the largest were used against heavy armor. An attack of the land batteries, in September and October, was cut short by the sinking of the bow of the "Jena" by a 9 4 inch shell. The leak was stopped and during three weeks the "Suffren" attacked every armored part of the "Jena" with the new standard and other 12 inch shells. A delay of four days was caused by the damage inflicted by one of these shots.

In November the superstructure was attacked from land, with 9 4 inch "P" shells. The firing tests at long range followed, and the experiments concluded, in the latter part of the month, with tests of the Watson exploder, attached to five 6 4 inch and six 9 4 inch shells. According to French journals more than 300 shells, of all calibers, were fired at the "Jena." The experiments were terminated by the exhaustion of the appropriation. They cannot be resumed very soon as the ill fated vessel was wrecked by a storm in December, and sank in five fathoms of water.

In regard to the results of the experiments, the accounts given by French newspapers and technical journals are incomplete and not entirely accordant, but we will attempt to select chiefly from Le Moniteur de la Flotte, La Vie Maritime et Fluviale, and Le Yacht the most probable data for criticism and comment.

The cast iron shells charged with black powder appear to have made very large holes in the plates of the "Jena," owing to the great number of fragments produced on explosion.

As no report of the behavior of cast iron shells charged with melinite is published, it may be inferred that these shells, which had already been condemned in principle, were not used in order to avert, as far as possible, all danger of bursting a gun, as such an accident would have been a serious obstacle to the restoration of confidence, which was one of the main objects of the experiment.

The armor piercing shells charged with black powder showed good penetrating qualities, but the small number of their fragments—five at most—made their subsequent destructive effects unsatisfactory.

The armor piercing shells containing 2 or 3 per cent of melinite, bursting into a much larger number of pieces, produced a correspondingly greater effect inside the armor, which they were equally successful in penetrating.

The excellent performance of the semi armor piercing shells, containing a 6 per cent charge of melinite, is emphasized in all of the reports. They easily penetrated armor of a thickness greater than half their diameter, and, even when striking at an angle of 40 degrees to the normal, they showed very good armor-piercing qualities. In exploding, they caused remarkable destruction.

The new standard shells (*obus alourdis*) charged with 3 per cent of melinite likewise gave very good results. Although an English report states that the 12 inch shells failed to penetrate the 12 6 inch amidship armor of the "Jena," a French journal regards as proved their ability to penetrate, in normal conditions and at a range of 10,000 feet, cementation steel armor of a thickness equal to their diameter. The retardation exploder worked perfectly, so that the shell always passed completely through the armor before exploding, and the explosion produced astonishing effects. The Vie Maritime mentions a rumor that some of these shells turned over in the air, but according to the Moniteur de la Flotte the *obus alourdi* has thoroughly proved its usefulness and requires only some improvement in detail.

The elongated shell containing 10 per cent of melinite (*obus allongés*) which were designed for the guns of medium caliber of the vessels in course of construction, apparently failed to fulfill the hopes entertained of them. At least, they did not produce the fearful havoc described in Szemenoff's account of the naval battle at Tsushima. They were shattered against heavy armor and exerted no destructive action. They penetrated thin plates but the centrifugal exploder came into action too late. Armor of medium thickness caused them to explode, but no destructive effect was produced behind the armor. The new Watson exploder was probably designed especially for these projectiles, when used against the superstructure and other unprotected parts, but no report of the performance of this device has been published.

The "P" shells of the coast artillery, charged with 17 per cent or 7½ pounds of cresyt, also proved unsatisfactory for similar reasons.

These experiments appear to prove that thin armor, which can be pierced by shells of medium caliber, is worse than useless. It causes the shell to explode, and thus spreads destruction behind it. It follows that, instead of making the thickness of armor equal to the caliber of the guns behind it, all vital parts, including the intermediate battery, should be protected by heavy armor. In order to assure sufficient penetration, the explosive charge of shells of medium caliber should not exceed 7 per cent of their weight. This is approximately, the charge of the semi-armor piercing shells used in these experiments, which proved that armor piercing power is very greatly diminished by increasing the charge of explosive from 5 per cent to 10 per cent of the weight of the projectile.

The explosive action of the armor piercing shells of all types proved eminently satisfactory and the Vie Maritime and other journals concede that the explosive charges demanded by many French technicians are excessive, as the effect produced behind the armor depends more on the armor piercing power than on the quantity of explosive. Szemenoff's description of the tremendous havoc wrought by the Japanese shells is regarded as an exaggeration. The retardation exploders used in most of the experiments worked excellently in connection with armor piercing projectiles, but they proved to be insufficiently sensitive for the shells employed against unprotected parts, and especially for shells with very high charges of explosive. For such uses better results are expected from the very sensitive Watson contact exploder.

According to some reports no fires were caused by the explosion of melinite shells. As the melinite shells used in the French army do cause fires, this statement suggested the question whether this negative result was due to the character of the exploder or to the fact that the melinite was poured into the naval shells in liquid form. According to other reports, however, a 6.4 inch shell, which struck a turret of the "Jena," started a conflagration which kept the turret red hot for an hour, and a 7.6 inch shell fired the ammunition in a casemate. The last-mentioned occurrence leads some critics to demand the removal of the emergency ammunition from the casemates, but Le Yacht advises its retention at the commencement of an engagement, when a rapidity of firing is demanded with which the apparatus for conveying ammunition from the magazine is utterly unable to cope. This journal adds that adequate protection against fire can be secured by a well-organized system of extinguishing fire and the removal of all combustible materials, and expresses the opinion that the numerous fires and suffocating smoke experienced by the Russian ships in the war with Japan were caused chiefly by the distribution of coal throughout the entire vessel.

In most cases the animals confined on the "Jena" escaped unharmed, unless they were struck or burned by exploding shells. Examination of the blood of those that were killed showed that death was caused by wounds, and not by poisoning with explosion gases. The "bombardment with carbonic oxide," described in reports of the Russo-Japanese war, was not manifested in the French experiments.

From all accounts the damage sustained by the "Jena" was chiefly internal and not conspicuous from without, as the holes were little larger than the shells. This statement includes the holes made by the very highly charged shells, when used with retardation exploders. The results of the experiments with the Watson contact exploder are not known. Le Yacht asserts, however, that the casemates and turrets were seriously injured.

Especially worthy of note is the statement that the apparatus for communication between different parts of the ship was made inoperative by the shocks caused by the first hits. A shot which struck the lower part of the armor belt broke electric wires on the third deck above. Hence it is of the utmost importance to fire the first shot, and it is also desirable to train the gunners to independent action, so that they can dispense with directions in an emergency. The steam and other pipes were greatly damaged by shock, which also loosened many rivets in the frames of the ship.

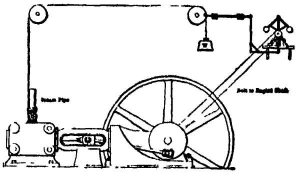
So far as is known, no accident occurred during these firing tests. This fact is very properly acclaimed by the French journals as one of the most important and gratifying results of the experiment, because it will restore the confidence in the guns and ammunition which had been seriously impaired by the frequent accidents of recent years. The semi-armor-piercing shells containing 6 per cent of melinite, and even the new shells with 10 per cent of melinite, may now be regarded as safe.

The lessons of the experiment will be applied at once to the armament of the projected warships, each of which will have a main battery of twelve 12 inch guns mounted in double turrets and using the new standard shell (*obus alourdi*) and a secondary battery of eighteen 5 5 inch rapid fire guns. The secondary battery is designed to ward off nocturnal attacks by torpedo boats, and also to demoralize the enemy in battle by their rapidity of fire and to injure vital and vulnerable parts by chance hits. The armor of all important parts of the new ships will also be increased, in accordance with the results of the firing tests, although not to the degree first contemplated. In order to avoid too great increase in displacement, the parts requiring protection will be concentrated as closely as possible. The secondary battery will be mounted in a central casemate with 8 7 inch walls, which will also protect the smokestacks.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Marine Rundschau.

A HOME-MADE ENGINE STOP.

By EDWARD T. BINNS

Some time ago the writer happened to be in the engine room of a manufacturing plant, when his attention was attracted to a rather ingenious device in the way of a home-made engine stop. The engineer explained that from some cause the engine had run away several times and in each instance disaster was narrowly averted. Accordingly, he had set about to produce an automatic engine stop at small cost. The accompanying sketch gives an idea of his apparatus. It is reported to have fulfilled its function faithfully several times.



A HOME MADE ENGINE STOP

There is a detachable drum fastened to the throttle of the engine with enough sash cord wound on it to correspond with the threads on the stem of the valve. The cord is run over pulleys and connected with a weight of sufficient size to unwind the cord from the drum as it descends, thus closing the throttle. Ordinarily the cord is wound on the drum and the weight suspended at sufficient height entirely to shut off steam in its descent. The drum comes off for starting and stopping and is placed on a hook out of the way.

The scheme for releasing the weight is that of a sliding bar, one end of which is caught under a pin in one edge of the pulley directly over the weight. As it is barely caught, an endwise movement of ½ inch will release the weight. The other end of the bar is connected to the upper end of a bell crank which is hinged at the elbow. The longitudinal arm of the bell crank is in contact with the stem of an ordinary flyball governor, which in turn is connected by a belt to the engine shaft. The stud of this governor is adjusted so that it will not act until the engine has reached a speed beyond the range of the regular governor, at which time the stem is passed downward, causing the weight to be released and a prompt shut-down is the result.—Power and the Engineer.

THE ARTIFICIAL SILK INDUSTRY.—I.*

CONVERTING WOOD INTO SILKEN FABRIC.

BY W. P. DREAPER, F.I.C.

In the French Exhibition of 1889 Count de Chardonnet exhibited his now well known process of manufacturing filaments of nitrocellulose by squirting collodion under suitable conditions into the air. The progress from this early production of highly inflammable filaments to the present production of the large output of artificial silk manufactured by this process which exhibits none of these inflammable properties and resists the disintegrating action of water has been achieved by careful research. To-day the production of the material by the original method starting with a solution of guncotton has met with signal success, and even in the absence of any competing process would have led to the building up an industry of a permanent nature from which the textile industry generally would have derived much benefit. This process of manufacture may in time go the way of most original processes and give way to the more direct methods of later date. At present it is responsible for about 50 per cent of the world's output. I have been informed in the Elberfeld Barmen district where 500 000 kilos are worked up every year that for some manufactures the nitro-product is absolutely essential while for others the newer products are of more value. If time proves that this is a normal condition then the mere cost of production will not be the only determining factor in the situation.

Any way it is patent to all those interested that great economies have been effected in this process more especially in the recovery of the solvents and their re-use in the rapidity of production and in other ways of which no one outside the actual works can have definite knowledge.

Of the processes which have survived to this industrial stage the three systems called respectively the nitrocellulose the cuproammonium and the viscose ones may be specially mentioned. These have been so controlled that they now produce a marketable product which is in such demand that delivery can only be obtained for the second half of next year at the earliest. This latter point is an important one for it is an indication that the newly founded industry is based on a genuine demand.

These yarns which range in size from 100 deniers upward are not adapted to the manufacture of such materials as are prepared from ordinary silk fibers of from 15 to 32 deniers or even upward but they enter into a whole range of articles and have had a profound influence on certain manufactures such as the braid industry and given employment to a large number of hands. The new uses which are being found almost daily for these products also indicate a steady and increasing demand for the yarns in the future. For example it is possible to manufacture a heavy cloth from these high denier yarns.

The early samples of the nitrocellulose product were extremely brittle and inflammable and lost 50—70 per cent of their strength on wetting. They were however extremely brilliant and this satisfactory factor certainly led to further research and improvements in other directions which gradually decreasing these objectionable features caused such a demand for the yarn in comparison to the possible supply that the price of this artificial silk for a time actually exceeded that of the real material. The extreme brightness of the goods made from it and their peculiar feel was undoubtedly the cause of this. With this state of affairs there is no wonder that the industry in France and Germany expanded and several companies were undoubtedly formed to work processes which had little chance of commercial prosperity. The patent list of these times also indicated the gradual expansion of the experimental work which naturally followed and was destined to give to these countries an absolute monopoly of manufacturing which they have held to all purpose until the last year or so and also to give to the textile manufacturers of these countries a first call on this important and novel product. The absence of the yarn itself in this country was one of the chief factors causing our neglect of this matter. The many difficulties of the process were emphasized by the failure of the English company (starting to manufacture under the Chardonnet rights) due it was then said, to local atmospheric conditions, the actual solution prepared in France refusing to spin at the Coventry factory.

Dr Lehner demonstrated his process in London but it was in Switzerland that he built up the enormous business which is associated with his name and which to-day turns out such large quantities of the nitro product. Chardonnet had to work with very high pressures but Lehner by modification of the solution was able to squirt at very low ones. He also squirted into water and in this way recovered the major portion of the solvent. The threads of nitrocellulose were wound on to bobbins and dried.

Factories producing such a product were destined sooner or later to come under the notice of the insurance companies. Serious fires took place and were unpreventable. It was found that the nitrocellulose yarn in the dry state like silk became highly charged with electricity and that self ignition took place. The risks were subsequently modified by keeping the yarn in a wet state until it entered the denitrifying bath. There was still the alcohol-ether to be reckoned with and it is I believe still impossible to insure such a factory. This mattered little however to companies making such profits. The Tubize Company rebuilt part of its factory a few years ago out of the year's income and still paid a good dividend.

Great speculation in shares high and fluctuating prices for the yarn fire at the works but most important of all an increasing demand for the product characterized the early days of the industry the slow and steady progress of which was assured and never in doubt.

HISTORY OF THE INDUSTRY

In 18[illegible]5 the well known French investigator Réaumur suggested the production of what might be termed artificial silk and in 188 Audemars patented the production from a nitrocellulose base but nothing more was heard of the process. In 1884 Count de Chardonnet deposited with the Académie des Sciences a sealed document which was opened on November 7 1887. It bore the title Sur une matière textile artificielle ressemblant à la soie. He had sufficiently worked out his process of manufacture to obtain a Grand Prix at the Paris Exhibition in 1889 for his product. He lodged his first patent on November 17 1884 (Fr Pat 16[illegible] 349). The first apparatus actually used for trials is shown in a photograph published in a work published by F Foltzer in 1903 (Fabrication de la soie artificielle parisienne).

In 1889 Du Vivier produced a product termed Soie de France but except in small details the production and product was very similar to that of Chardonnet. In 1892 Lehner patented his modification of the Chardonnet process (Fr Pat 221 901 May 25 1892).

As a result of these early inventions the following centers have produced this nitrocellulose product in large quantities. Works at Besançon in France at Tubize and Droogenbosch Ruysbroeck in Belgium at the four factories of the Vereinigte Kunstseide Fabriken of Frankfort at Kelsterbach a M at Robingen near Augsburg Glattbrugg and Spreitenbach near Zurich at Padua in Italy and in Hungary.

The first patent connected with the production of artificial silk from cellulose dissolved in a cuproammonia solution was that of Despeissis (Fr Pat 203 741 Feb 12 1890). The only remaining record of this appears in a French publication as under the French law of that date the specification was not printed and being abandoned owing I believe to the untimely death of this investigator is not available for reference. Nothing more was heard of this process until Pauly in 1897 patented a process on very similar lines. The English specification has since been restricted by amendment so that the original suggestion of Despeissis viz the addition of a proportion of some albuminoid substance to the solution has been omitted in the latter specification. In 1899 (Eng Pat 6556 1899) Fremery and Urban took out their first patent dealing with details in the manufacture. In the same year (Eng Pat 18 260 1899) Bronnert patented his first improvement in connection with the direct solution of cellulose although he had previously in 1886 (Eng Pat 6858) taken out a patent for improvements connected with the nitrocellulose process.

Pauly Bronnert Fremery and Urban are for ever associated with the industrial application of the copper ammonia process on the large scale they have through their investigations led to the development of the celebrated Glanzstoff Company, which to-day employs over 7 000 hands and manufactures such large quantities of this product. Its headquarters are at Elberfeld and works at Niedermorschweiler and Oberbruck in Germany and it is also interested in work at Givet and at Izieux in France (Messrs Gillet et Fils). I believe that a Spanish company the Sociedad Española de seda Parisien has ceased working. The British Glanzstoff Co Ltd has recently started works at Flint which it is said will give ultimately employment to 2 000 hands. It is understood also that works will shortly be erected in Russia.

In 1902 Thiele took out his first patent for improvements which enabled much finer filaments to be spun than heretofore. This and subsequent patents suggested a possible development in the industry (Fr Pat 320 146) in competition with the natural article.

Since that date the patents registered in connection with this copper ammonia process have been very numerous. Only time will demonstrate their respective merits. In some cases copper carbonate in ammonia is used to dissolve the cellulose. Many patents deal with the use of different precipitating solutions and details in the process such as for instance the preliminary mercerizing of the cotton.

In the early days there were in this country several investigators of note working on the subject of artificial filaments amongst whom may be mentioned Crookes Swinburn Wynn and Powell and Swan also the first patent for a direct process of manufacturing from cellulose was taken out by two Englishmen in 1884. It was not until six years after this date that Despeissis took out his first patent which formed the basis for the early working of the cuproammonium process. It remained for France and Germany to bring this industry to a successful issue. However having recently reached a state of manufacturing efficiency as at the Coventry Viscose Works we have made up for lost time.

It was natural that France with the silkworm industry so firmly established in the South should look with greater interest upon the possible manufacture of an artificial product which might supplement the natural supply. The fact that Pasteur was instrumental in saving that industry from decay may also have had an influence in intensifying the belief that the problem was capable of commercial realization through the aid of scientific research.

(To be continued.)

THE BAT

The small brown bat (*Vespertilio subulatus*) despite its unpopularity is a creature not devoid of interest. It is hoped that the following observations recently made upon a live specimen of this animal may be worth mentioning.

The most noticeable characteristic about the animal was the peculiar stale odor which accompanied it. Another equally unpleasant characteristic was the fact disclosed by an examination of its fur that it was quite numerously populated by a species of louse. The respiration of the animal was plainly visible and the average number of counts when the animal was in a state of repose gave as a result 160 respirations per minute. Naturally the respiration suggested the taking of the animal's pulse. This at first seemed difficult to do but the problem was solved when the observer bethought himself of a stethoscope that happened to be available. This was one of the telephonic type of instrument the diaphragm being connected with the ears of the experimenter by two rubber tubes. The bat was placed in a Mason jar over the mouth of which was tied a paper cover. The jar was now inverted and placed upon the diaphragm of the stethoscope so that there was nothing between the bat and the instrument except a thin layer of paper. The heart beat of the little creature was now plainly heard but was far too rapid to be counted. In order to estimate the number of beats it was necessary to catch the rhythm of the heart beat by tapping alternately with the two hands upon the table counting the taps of one hand only and doubling. This gave as the result an average of 448 heart beats per minute. This is approximately three times the number of respirations per minute. The rate of respiration and heart beat was very much influenced by the nervous condition of the creature. Before each trial it was necessary to wait some little time with everything quiet until the frightened animal became composed.

Cement for Repairing Hard Rubber or Vulcanite.— This is a mixture of molten guttapercha and natural asphalt and is applied hot. The hard rubber articles must be kept pressed together till the cement cools.

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* Paper read before the Society of Chemical Industry and published in its Journal.

THE GREAT DOLMEN OF BISCEGLIE.

INTERESTING RELICS OF PREHISTORIC MAN.

One of the most important events of recent years in the field of prehistoric archæology is the discovery on August 6th in Bisceglie of a megalithic monument of remarkable size

This great dolmen was found by the well known Italian antiquarian Senator Mosso Prof Mosso had conceived the idea of excavating the prehistoric site of Pulo di Molfetta Accompanied by Don Francesco Samarelli he made three expeditions into the interior of Molfetta with the object of searching for traces of neolithic villages like those of the neolithic necropoli of Pulo previously discovered by him A laborer one day informed Samarelli that a sort of stone hut existed at the bottom of his employer s farm

Investigation of the man s statement led to the finding of this remarkable monument

The dolmen is situated at a distance from Pulo of about one and one half hours ride by carriage being just 6 kilometers from Bisceglie on the road which leads to Ruvo on an estate belonging to Signora Lucietta Benaducci Pasquale opposite la Chianca

This dialect term meaning the table doubtless was derived from the principal part of the monument and is indeed an equivalent of the Celtic word dolmen used in Lower Brittany which signifies table of stone

Dolmens are classed among megalithic monuments and have usually the form of a chamber with sides and a roof formed by huge stones though sometimes they seem to be natural caverns (*[illegible]*) without sides

In France about four thousand such monuments exist none of them however being comparable in size or beauty to this one of Bisceglie

As shown in the accompanying diagram a quadrangular cell is made by the three huge stones *a b c* two forming the sides and one the floor while a fourth and larger stone *l* serves as the roof

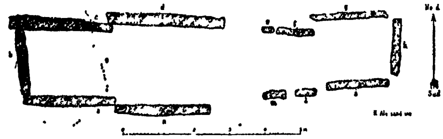
The opening of the cavity is toward the east The stones excavated on the spot are placed with the smoothed side on a pavement of the living rock and are held erect by their own weight and the strength of contact

The left side has at the top two nearly circular apertures which would appear from their contour to be due to natural causes Such apertures however are a general feature of Celtic tombs and considered by archæologists to be designed for the ingress of the soul

Of the two sides one measures [illegible] meters in depth by 2 10 meters in height The other measures 2 0 meters by 2 1 meters The bottom stone has the dimensions 1 9 meters by 0 meters The top stone is 3 9 meters long by 2 40 meters wide and varies from 0 [illegible] meter to 0 13 meter in thickness

A corridor or dromos leading from the cavity is 7 80 meters long and 2 0 meters wide near the cavity and 1 70 meters wide at its farther extremity The stones *d f g l i l m n* deeply imbedded in the earth form its outline This corridor must originally have been covered but at present all the stones are overthrown with the exception of the two adjoining the cavity Of these *d* at the right is 10 meters long Before excavation the monument stood 1 65 meters high and was imbedded to a depth of 5[illegible] centimeters

Within it were found human bones including those of youths and adults There were also various fragments of vases a portion of a necklace of well baked clay in the form of two truncated heptagonal pyramids united at the base a flint stone of pyramidal shape pierced by a hole for suspending it perhaps as an amulet a flint stone rounded like a hammer a chip or splinter of flint and finally various bones of oxen mingled with ashes and charcoal doubtless the remains of funeral banquets consumed in honor of the dead



PLAN OF THE BISCEGLIE DOLMEN

The skeletons were in disorder and confusion with the exception of two pairs of legs crossed at the knees

By analogy with similar monuments it might appear that the corridor formed merely a vestibule to the sepulchral chamber but on digging at its opposite end the remains of three dolichocephalic skeletons were found with more fragments of vessels

It is evident moreover that the narrow end turned toward the east where we conceive the entrance to [illegible] was closed by a stone of which the lower part imbedded in the earth has been preserved Consequently ingress to the tomb must have been through one of the two long sides

The reader will be enabled to form an estimate of the unique importance of this monument by a mere statement in regard to the similar antiquities previously known

A single dolmen of Corsica measures 1 38 meters in height None of those of Lecce exceeds a meter in most of them the sides which sustain the roof are not monoliths but are composed of a number of smaller stones placed one on top of the other In none of them is found the dromos or corridor In none of them have been found skeletons with corresponding utensils

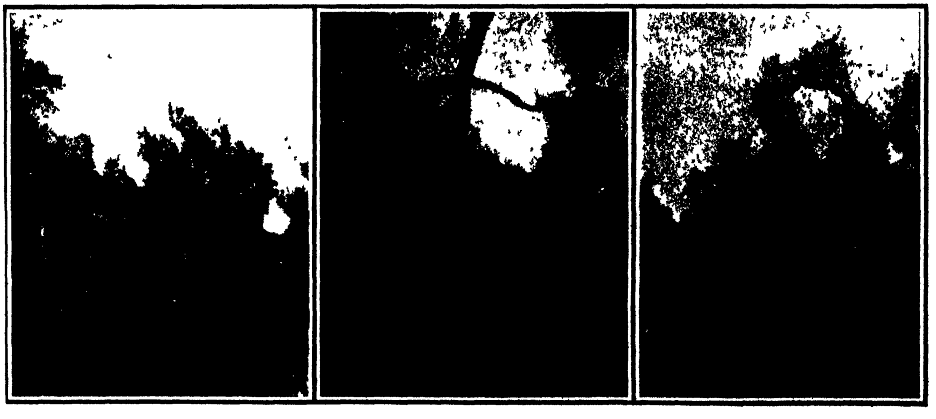
Hence we may affirm that the Bisceglie dolmen is the largest the most perfect of the ancient monuments of Italy and one of the most beautiful and interesting in Europe

For many centuries popular fancy has designated these monuments as the homes of fairies giants or devils or as the retreats of legendary heroes such as Roland or Gargantua During a revival of heathen idolatry in the middle ages they became objects of reverence and as such were anathematized by the Catholic church and many were destroyed in consequence of an edict of Charlemagne

Dolmens previously known in Italy are found in the Terra d Otranto scattered along the shores from Castro to Otranto four at Giurdignano two at Minervino one at Palmarigi two others at Leucasfride and at Ricettulla near Taranti discovered last year by Prof Mosso but none so large as this of Bisceglie

Except in India and Syria dolmens are found distributed over a long uninterrupted strip of territory which excluding Egypt traverses Northern Africa crosses the Strait of Gibraltar and by way of the Iberian Peninsula France and the low countries extends finally along the southern coasts of the British Isles and Scandinavia No dolmens are known in Northern Italy in Switzerland in Southern and Central Germany in Austria Hungary or in Russia except a few on the shores of the Black Sea

It is thus evident that a current of civilization from the Orient propagated itself along the southern coast of the Mediterranean and in Western and Northern Europe and that another current of civilization perhaps likewise of Oriental origin but which marched to conquest by ascending the sources of the Danube checked its spread in Central Europe —Condensed for the SCIENTIFIC AMERICAN SUPPLEMENT from L Illustrazione Italiana



THIS GREAT DOLMEN WAS DISCOVERED BY MOSSO LAST YEAR IT IS A HUGE MEGALITHIC MONUMENT OF CELLULAR CONSTRUCTION, BUILT IN PREHISTORIC TIMES.

THE GREAT DOLMEN OF BISCEGLIE

According to Electrical Engineering rules have been issued to the effect that no apparatus for wireless telegraphy on board merchant ships whether British or foreign shall be used while in any of the harbors of Gibraltar except with the written permission of the governor The making or answering of signals of distress is excepted The bill requiring all steamers to be equipped with wireless apparatus which was introduced in the Canadian Parliament, has been shelved for the present, for the reason, it is said, of seeing what steps the British government is taking in this direction.

FALCONRY IN THE MIDDLE AGES.

THE SPORT OF KINGS AND THE KING OF SPORTS.

BY DR. HANS BOLLMER

In the middle ages falconry or hawking was regarded as the king of sports as it was the sport of kings It is one of the oldest forms of hunting and its origin has been traced back to ancient nomadic tribes of Central Asia by whose descendants it is still held in high esteem According to a Greek myth King Demetrius was the first to hunt with the falcon the sacred bird of Apollo In Egypt divine honors were paid to falcons and the god Osiris was depicted with a falcon s head Falcons were believed to cure disease to live 700 years and to possess the power of prophecy after their death According to the legend Demetrius amused by the lively movements of a falcon which he discovered soaring over the palace gardens caused the bird to be caught in a net blindfolded and fettered to his throne until it became tame Seeing the falcon dart in pursuit of a snake and swoop down on a dead hare that had been brought as a present the king carried the bird with him on his next hunting excursion and released it on flushing a partridge which the falcon quickly captured

THE START FOR THE HUNT

From an old copperplate

TWO HUNTSMEN WITH FALCONS

From an old copperplate.

That falconry was practised by the Persians Turks and Arabians in very ancient times is known from well authenticated accounts The sport appears to have been brought to Central Europe during the great migrations of the first centuries of our era It was practised in Europe until late in the eighteenth century after which it rapidly declined owing to the improvement in firearms and the abolition of feudal privileges It attained its highest development in France in the reign of Francis I (1494 1547) It still flourishes in Persia and in the Sudan In Asia falcons are chiefly employed in connection with hounds in hunting gazelles and antelopes while in Europe they were used in the chase of herons cranes, ducks pigeons ravens partridges pheasants swans hares and rabbits As early as the time of Charlemagne falconry had become the favorite sport of the nobility and the emperor ordered hunting falcons to be kept at the court of every princely vassal Charlemagne is said to have been the first to attempt to hunt with eagles but these fierce and dangerous birds never became popular It is narrated that Charlemagne sent a trained eagle to the Persian king Behram with the information that the eagle was a better hunter than the falcon When the eagle attacked and killed Behram s young son the Persian monarch concluded that it had been sent with malicious intent and sent Charlemagne a tiger with the information that the tiger was a better hunter than the panther The credulous Frankish monarch proceeded to train the tiger for the hunt by starving him but the experiment was ended by the tiger devouring the emperor's brother whose curiosity had led him too near the famished beast

STARTING FOR THE HUNT

From an old manuscript

That falconry was practised extensively before the time of Charlemagne is proved by the oldest known German codes of laws of the fifth sixth and seventh centuries and by the later Saxon and Swabian codes which prohibited the injury or theft of hunting falcons under heavy penalties At all times at least in Germany falconry remained an exclusive privilege of the princes and nobles It was a very expensive sport the cost of which was out of all proportion to the value of the booty The employment of falcons gradually became restricted to heron hunting which provided the most exciting sport and the most brilliant spectacle and which was conducted with prodigal extravagance As wild herons could not always be found herons were bred for the sport and choice birds were bought at high prices and brought from great distances So the idea of utility vanished completely and falconry became an expensive pastime of the wealthy nobles The importance attracted to the sport is proved by the extensive literature to which it gave rise A formal science of falconry was developed and even kings deigned to expound its theories at length The German emperors Friedrich II and Maximilian wrote treatises on the subject Until the sixteenth century every nobleman kept his falcon and many princes and lords carried their falcons perched on their hands even in church Ladies also indulged in the sport and the pet falcon like the lapdog of a subsequent period was the constant companion of its mistress

TRAINING FALCONS

From an old wood engraving

GOING HAWKING

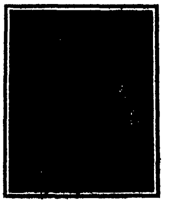
From th B [illegible] A D [illegible]

Not every kind of falcon is suitable for hunting The favorite bird was the gerfalcon or Iceland falcon the largest of the true or noble falcons which on account of its rapid and lofty flight was so greatly preferred for heron hunting that it came to be known as the heron falcon The female bird was preferred to the male because of her superior size and strength Another favorite hunting bird was the hawk which was used especially in hunting hares rabbits cranes and pheasants but also for heron hunting and was regarded as the most eager fearless persevering and docile of all hunting birds The goshawk was also a favorite because of its spirit and courage although it had the reputation of being short lived The bearded vulture or lammergeier was employed in hunting deer foxes and wolves and the sparrow hawk in the chase of quail and larks

The training of falcons was a difficult process which required great patience perseverance sympathy and intelligence The falconer of a great lord was an important personage and ranked with artists He was not allowed to have any other occupation but was required to devote his whole time to the care of the falcons His first task in training a young falcon was to win the confidence and affection of his pupil If the bird had not been bred in captivity but had been caught in the wild state its eyes were covered with a hood and its claws were fettered After a week of captivity the hood was removed and the falcon was gradually accustomed to the sight of its keeper and the dogs the falconer taking care to avoid looking too fixedly at the bird at first This stage of training is illustrated in an old wood engraving herewith reproduced It was deemed especially important to carry the young falcon on the hand as

HUNTING HERONS WITH FALCONS

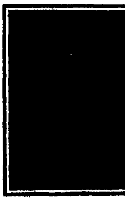
From an English copperplate about 1[illegible]



HUNTER WITH FALCON.

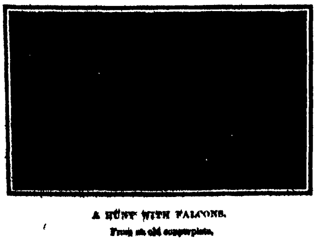
From a painting by Franz Hals in the Brunswick gallery.

ROBERT CHESEMAN, FALCONER TO HENRY VIII



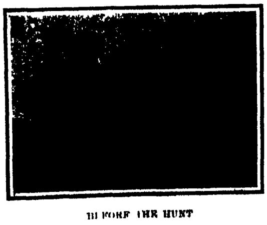
THE FALCONER.

From paintings by Hans Holbein the Younger in the Hague gallery



A HUNT WITH FALCONS.

From an old copperplate.



BEFORE THE HUNT

From a painting by Philips Wouwerman in the Hague gallery

FALCONRY IN THE MIDDLE AGES.

much as possible In order to guide the instinct of the falcon in the desired direction it was fed on the flesh of the species of bird which it was being trained to hunt for every falcon was educated with reference to some particular kind of game After the falcon's confidence had been won it was exercised in attacking its quarry in the following manner A heron (or other bird) with its neck bandaged to prevent the falcon from inflicting a mortal blow with its beak tipped with bits of elder cane to prevent it from wounding the falcon and with a strong cord attached to its leg was set down in a field about forty paces in front of the hooded falcon When the hood was removed the falcon darted toward the heron which either crouched and attempted to hide in the grass or betook itself to flight and was usually soon overtaken by the swifter falcon In either case a combat ensued on the ground which was terminated by pulling the quarry away by means of the cord while the falcon's attention was diverted by an offer of food This maneuver was repeated many times and the falcon was gradually taught to leave the quarry and return to his master at the call of the latter If the falcon did not promptly obey the call it could usually be brought to obedience by coaxing and the promise (which experience appeared to make intelligible) of reward in the form of a fat pullet or pigeon Failure of these means of persuasion indicated that the falcon was surfeited or too fat In this case the falcon was removed by force from the quarry If the falcon on the other hand showed no inclination to pursue the heron a hunting spirit was inculcated by means of a course of fasting The work of tuition was sometimes facilitated by associating the young falcon with an old and experienced bird which first attacked the quarry and substituting the young falcon for the old one after the heron had become more or less exhausted by the struggle In this case the young falcon was allowed to kill and devour the quarry but if it refused to attack the heron the hunger cure was applied

The aristocratic character of falconry was largely due to the fact that the sport was never pursued on foot The noble lord rode to the chase with his hooded falcon on his hand accompanied by dogs trained to start the game When the quarry came in sight the falcon's hood was removed and the hand which carried the bird was shaken The falcon instantly spied the quarry darted in pursuit and quickly overtook it The heron often made a spirited defense and a fierce battle in the air ensued which usually was won by the falcon which was stronger though smaller than its adversary Occasionally however the highly prized falcon was transfixed by the long and sharp beak of the heron More frequently some of the falcons escaped during the hunt raided neighboring poultry yards and were killed by irate peasants A heavy penalty however was soon attached to the killing of a falcon and a correspondingly high reward was paid for restoring an escaped falcon unharmed to its owner The falcon was captured by offering it food and seizing the fetters which were attached to the legs of every hunting bird Touching the wings or tail was prohibited

Some falcons had a bad habit of turning aside from the quarry and settling on the limbs of trees A bird which showed this peculiarity was taken out repeatedly on frosty and rainy days until the chilling of its feet by contact with the frost covered branches and the soaking of its plumage with rain induced it to abandon the habit

Falconry like many other institutions of the good old times has become invested with a halo of romance but it was in reality a cruel and bloody sport which has very properly been abolished by the advance of civilization – Die Gartenlaube

ARTIFICIAL PRECIOUS STONES.*

LABORATORY MIMICS OF NATURE.

BY PROF DR. M. BAUER OF MARBURG.

If I have undertaken to report on the artificial production of precious stones which is now practised on such a large scale I do not of course intend to refer to imitation substitutes which are so frequently palmed off for genuine stones but only to such materials as are perfectly identical with the respective minerals in their entire constitution chemical composition form of crystals and physical properties

We are dealing here with mineral syntheses differing from ordinary attempts of this kind only by the experimenter's endeavor to give the artificial product not only its general essential characteristics but the handsome appearance required of a gem and due to transparency luster color etc and also the necessary size It will be evident that only gems of a relatively high price can be considered in practice since they alone will give the manufacturer an opportunity of covering the rather high cost of production by realizing a good price for the artificial stone The list of gems which we may attempt to reproduce artificially is therefore rather restricted at the outset and this applies with even greater force to stones in the case of which favorable results have been obtained already At present attempts at artificial production must be limited to the turquoise and stones in the mineral group of corundum

The first successful experiments were probably made with the turquoise an aluminium phosphate which is opaque crystalline and is water bearing and owes its fine blue color to a small percentage of copper As long ago as the last quarter of the nineteenth century there appeared on the market turquoises which resembled genuine stones to such a degree as to deceive experts yet jewelers suspected that they were imitations No difference from indubitably genuine natural stones could be detected in their appearance and the constitution the specific gravity and the microscopic structure are substantially the same Later it was ascertained as a matter of fact that artificial turquoises were being made in Paris and Vienna in large quantities according to some method details of which have not been disclosed It is said to be a process involving precipitation from an aqueous solution a loose precipitate of copper bearing aluminium hydrophosphate being obtained which is then compacted by strong pressure It is impossible to tell this product from a genuine turquoise with certainty by the mere appearance and the usual tests and the only material difference in behavior is said to appear when a high temperature is employed

In more recent times much greater prominence has been reached by the artificial production of gems belonging to the group of corundum which is aluminium oxid forming hexagonal rhombohedric crystals In this group is included the blue sapphire the yellow Oriental topaz and other stones commonly termed Oriental and chief of all the ruby which in its finest specimens surpasses in value all other gems even the diamond In the class of transparent gems the first great success has been achieved with the artificial production of this most precious of all gems in specimens available for commercial purposes This entire industry is now dominated by the manufacture of artificial rubies All other syntheses of this kind which are allied to it are of so much less importance that I shall refer to them but briefly

Gaudin a Frenchman was probably the first to produce artificial corundum His procedure (begun 1837 and repeated several times) involved melting at high temperatures The same result has been obtained since in a similar way by many other chemists and mineralogists as H Sainte Claire Deville Ebelmen Ch Friedel Morozewicz etc But in all these cases the product was of poor appearance dull of bad color and often consisted only of minute crystals many of them of microscopic size The Goldschmidt thermit process does indeed yield large amounts of corundum but this is entirely unavailable as a gem and is only of value for technical purposes on account of its enormous hardness

While the production of common corundum therefore is easy the production of the beautiful transparent finely colored precious corundum remained exceedingly difficult for a long time Let us first consider the ruby which owes its beautiful red color to a small percentage of chromium

The first artificial product worthy of being cut dates from the early eighties of the last century I refer to the so-called reconstructed rubies or Geneva rubies (rubis de Genève) it being supposed that they were made in Geneva It is now believed to be established that they were obtained by melting together ruby fragments with the addition of partly lead bearing fluxes The beautiful red color of the ruby is preserved but its hardness is somewhat diminished and sometimes the entire mass will become amorphous and glassy so that the double refraction and the dichroism characteristic of the ruby will disappear Other specimens while not entirely amorphous show that they are not uniform crystallographically and optically Examination with a polarizing microscope reveals the fact that some ruby fragments (although not discernible to the naked eye) have remained substantially unaltered and imbedded in a glassy body A greater or smaller number of microscopic air bubbles are always present but they are not detrimental The stones have a good appearance and may be made of a pretty good size (several carats) After being an article of some importance for a while they now seem to have vanished from the market almost entirely They are not true artificial products in the sense spoken of above since the raw material is genuine natural ruby The manufacturer's aim in this case was simply to produce from many worthless small particles larger pieces of apparently great value but this could not be done without at least partial destruction of the ruby substance The process has remained a perfect secret but in any event it does not accomplish the actual reproduction of rubies that is the production of a crystallized red aluminium oxid capable of being cut from suitable raw materials of a different character This true synthetic reproduction of rubies shall now be discussed more fully

The French chemist Frémy was the first who attained results of some utility and in 1891 he published a process originally worked out by him in conjunction with A Verneuil This process is based on the fact that at a high temperature the action of hydrofluoric acid and water upon amorphous alumina will promote its crystallization Pure precipitated alumina was melted at a heat of about 1 500 deg (Centigrade) in a muffle furnace in the presence of some potassium carbonate a small amount of BaF_2 or CaF_2 with the addition of about 2.5 per cent of $K_2Cr_2O_7$ A platinum crucible should not be used but a clay crucible it having been found indispensable to have the moist air and the steam bearing combustion gases penetrate the molten mass The amorphous Al_2O_3 was thus gradually converted entirely into a mass of Al_2O_3 crystals It was found that in order to obtain a fine product the employment of raw materials of absolute chemical purity was essential particularly as regards the alumina The size of the crucible greatly influenced the size of the crystals produced Small crucibles yielded only small crystals and the larger the vessel or in other words the larger the molten mass the larger were the rubies produced These always had the rhombohedric crystal form of the genuine natural ruby They were thin plates bounded at top and bottom by the wide base surface and at the edges by the very narrow surfaces of the main rhombohedron and measurement showed the characteristic angles of the ruby reproduced exactly Like the form of the crystals the physical properties as the specific gravity (4) the hardness (9) and the optical conditions were absolutely identical with those of natural rubies The product was an artificial ruby of perfect transparency and clearness and (owing to the chromium contents) of a very beautiful red color although a few specimens exhibited the blue color of sapphire The product therefore from its properties was eminently suitable for use as a gem but it had one very important defect which lay in the small size of the crystals even the largest of them making them unfit for practical use The width of the thin plates seldom exceeded a few millimeters and their thickness was always even much less so that one could hardly think of cutting them It was therefore attempted to set the entire pretty tiny crystals in their natural form in various articles of jewelry and some handsome objects of adornment were obtained in this way Notwithstanding the artificial production according to this method never attained commercial importance its use remained limited and soon stopped altogether Frémy indeed expressed the hope of being able to produce crystals of practically available size by melting large masses up to 50 kilogrammes, but evidently the experiments were unsuccessful, as nothing further was heard of them These were the so-called scientific rubies (*rubis scientifiques*)

Another article, however has acquired considerable importance in the gem trade and now dominates this department of the market, and this is the synthetic ruby (*rubis synthetique*) In the raw state these synthetic rubies are of an appearance entirely different from that of the small crystals of scientific rubies, and judging by their appearance, raw synthetic rubies would not be suspected of being large ruby crystals of uniform structure. The process of manufacture also is materially different. This process was described in

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* Translated for SCIENTIFIC AMERICAN SUPPLEMENT from a paper read before the Verein Deutscher Chemiker

1902 by the Parisian chemist A. Verneuil, and is now employed, with greater or smaller modifications of details, for the production of very large quantities of beautiful artificial rubies and occasionally other gems of the corundum group.

The most important of the raw materials in this case also is alumina, and the coloring principle chromium oxid. Both should be chemically pure and particularly the presence of even the slightest amount of iron should be avoided, since otherwise the product will take the little valued orange-red tinge which makes the Siam rubies so much inferior in value to Burma rubies. In order to secure uniform coloring the mixture of chromium oxid and alumina should be perfectly homogeneous. With these requirements in view Verneuil proceeds as follows: He makes an aqueous solution of ammonium alum and chrome alum (obtained free from iron by repeated crystallization) in proportions corresponding to the desired shade of color and from this solution, while hot, he precipitates chromium oxid bearing alumina by the action of ammonia. The precipitate is dried in the air first at ordinary temperature and then at a cherry red heat and is finally melted while in a powdered condition, in a peculiar apparatus designed for this purpose.

The apparatus consists in its leading features of an oxy-hydrogen blowpipe directed vertically downward, its flame being produced by illuminating gas (preferably containing a large proportion of heavy hydrocarbons) in conjunction with oxygen of the greatest possible purity. The tube through which the oxygen is supplied has at the top an enlargement in which the alumina powder to be treated is placed upon a fine mesh platinum sieve. A little hammer actuated electrically, strikes this sieve at short intervals and each blow causes a cloud of the fine powder to issue downward from the sieve, the powder being then carried along by the oxygen current under pressure and thus conveyed to the flame. There the small particles are melted and are caught on the vertex of a small cone also made of pure alumina, the so-called foot, which is disposed beneath the flame and is heated by it to incipient fusion. A few screw threads permit the cone to be raised or lowered as required and to be shifted laterally during the operation, the progress of which may be watched through sights, the attendant using dark spectacles.

During this treatment a thin rod will at first grow upward from the foot, that is from the tip of the incandescent alumina cone, this rod becoming thicker fairly quickly and finally developing into a round ball of greater or less regularity. The finished formation resembles a pear or rather an inverted water bottle having a thick and wide body, the neck of such bottle adhering firmly to the foot, which must be renewed at each operation. The place of junction is thus very small and this is of extreme importance, preliminary experiments having shown that if the solidified molten drop has a wide surface of adhesion it will always exhibit many cracks and thereby become unsuitable for cutting. The reduction of the diameter of the molten drop at its point of contact with the foot overcame this objectionable result in the main, but still for a long time the finished drops after solidification would often split lengthwise into two halves with a tolerably smooth cleavage surface, each half having then to be cut separately. Later improvements enabled this defect to be avoided and the entire drop now yields a single stone of double size, of course cut according to the usual methods.

In this process of manufacture the apparatus must be disposed and adjusted very carefully and particularly the gas tubes should be absolutely vertical. Furthermore the pressure of the gas and of the oxygen must be regulated properly according to empirical data, as the treatment progresses. Apart from this the procedure is very simple and one workman can attend at the same time to several apparatus placed in the same room. According to the more or less favorable course of the operation, which to some extent is governed by uncontrollable accidental influences, the drops vary in size somewhat. The largest drops are about 1.5 centimeters thick and 2.5 centimeters long or several millimeters longer if we include the thin neck. The weight may be up to 50 carats (about 10 grammes) and the cut stones have a corresponding size. I have seen some as large as 12 carats.

The entire mode of production makes it clear that these molten drops, considered chemically, are nothing but pure alumina, mixed in varying proportions with some chromium oxid. If the amount of chromium oxid is slight, the color will be light pink. Stones of this character have been termed erroneously synthetic topazes on account of their striking resemblance to the so-called pink topazes which are obtained by heating yellow Brazilian topazes. Genuine synthetic topazes, however, have not yet been produced. If the amount of chromium oxid is increased, say up to 2 per cent or a little more, beautiful dark red stones of various tints will result, among them fairly often the rare and highly valued pigeon blood red of the natural Burmese rubies, the pure carmine red. It seems that these different shades of red still depend, in the main, upon accidental causes, so that at present they cannot yet be produced at will. If the chromium oxid is omitted altogether, quite colorless drops are obtained which correspond to the white sapphire. Whatever the color, the mass is perfectly clear and transparent, except at the bottle's neck and its bottom, that is the part formed last during the process, where the drop always terminates with a thin cloudy white or grayish layer. With the polarization microscope we can observe that each drop represents a complete unitary crystal whose crystallographic principal axis and optical axis frequently but not always extend lengthwise in the direction of the bottle's neck. It is true these crystals are generally rounded off externally so that their true nature cannot be perceived at once with the naked eye. In rare cases however the bottle-shaped body exhibits six fairly regular plane surfaces parallel with the direction of the axis which intersect in six similarly regular edges under angles of 120 deg. corresponding to a hexagonal prism and to the natural characteristics of a ruby. Minute ruby crystals are frequently found in large numbers on the bottle neck and on the small alumina cone or foot. As with the scientific rubies all other properties are like those of natural rubies, such as specific gravity, hardness, coefficients of refraction, dichroism, etc. In brief here again we have an artificial ruby which is absolutely identical with the natural ruby in every respect, chemically, crystallographically and physically. As it also possesses the size, clear transparency and magnificent color required of a precious stone suitable for jewelry, it may be said that with these synthetic rubies the problem of artificially producing this valuable gem has been thoroughly solved in the main. The methods of production may perhaps be further improved, but the product itself is hardly susceptible of greater perfection.

This is therefore the process of manufacture which has acquired such importance since 1902. A. Verneuil, who is using it upon a large scale in Boulogne near Paris, states in one of his publications that during the last six or seven years he and others have made there annually more than five million carats (1,000 kilogrammes) of these artificial rubies. In Germany the Deutsche Edelsteingesellschaft Zu Idar, according to its circular, is carrying on the same manufacture employing a special process worked out by Prof. A. Miethe of Charlottenburg, details of which are not available.

The question will be asked if it is possible to distinguish these artificial rubies with certainty from natural ones. At first this was comparatively easy. The synthetic stones produced first, when viewed under the microscope, showed numerous round air bubbles which, it is true, did not impair their fine appearance. But these bubbles are entirely lacking in natural rubies, which on the other hand sometimes contain small angular cavities, so-called negative crystals, and also minute real crystals. Among these there are especially noteworthy microscopic brown needles which are often found ingrown in the crystals parallel with the base in three directions intersecting under angles of 60 deg. Improvements made in the manufacturing process have led to the almost entire disappearance of the small round bubbles, but the tiny needles, etc., characteristic of natural rubies cannot be embodied in the artificial ones, so that the presence of such needles, etc., indicates a natural ruby with certainty. If they and the round bubbles are both absent then no microscopic test of genuineness will be available.

In regard to telling the difference by the mere appearance without the help of instruments, it should be noted that experienced gem connoisseurs assert they can always recognize an artificial ruby as such and distinguish it from a similar natural ruby. They say that even with the finest color and the most perfect qualities producible artificially the synthetic stone still always lacks the beautiful velvety gloss of the natural product. Be that as it may, it certainly requires a very large experience and I must confess that I have not reached this point as yet. I have seen a great many artificial and natural rubies both separately and side by side, but I have not always been able to distinguish them with certainty.

It will therefore be readily understood that this manufacture has caused considerable anxiety in the ruby trade, all the more in view of the fact that the price of even the best synthetic stones, which at present amounts to about 75 cents per carat (0.205 gramme) is far below that of corresponding natural rubies. A one-carat natural ruby of the finest quality may cost more than $250, a two-carat stone up to $2,500 and still larger ones on account of their scarcity are sold at often incredible fancy prices. On the other hand, synthetic stones of 10 carats and over, which size natural stones have attained in only a few instances, can be produced artificially with great ease.

It is not surprising therefore that the owners of natural rubies should have devised steps to guard against the seriously threatened depreciation of their dearly-acquired possessions. Thus, among others, the syndicate of Parisian dealers in precious stones resolved that the name "ruby" should be applied only to stones cut from natural raw material and that every jeweler should be obliged to expressly declare artificial stones sold by him and to unconditionally take back any artificial stone brought into the market by him unwittingly. It is of course very doubtful if the sale of artificial rubies can be effectively checked by such measures for any length of time, since the recognition and distinguishing certainly are very difficult, to say the least, and of course entirely impossible in the case of the general public. No doubt very many synthetic rubies have been brought upon the market without declaration with and without the seller's knowledge and have been accepted as natural by the public. The surprising fact has also been ascertained that the manufacture of artificial rubies has not caused a fall in the price of natural rubies; on the contrary it has gone up somewhat since that time. The fears of the owners of natural rubies are therefore unfounded, at least for the present.

Besides rubies, artificial stones of other colors, all belonging to the variegated group of precious corundum, have been made according to Verneuil's process and placed on the market, but the coloring agent is not generally known in most cases. Compared with rubies this is of some scientific but of no economic importance. The natural stones of this kind have only an inferior place in the precious stone trade and their price is not so very high, so that their reproduction is not remunerative in the same degree as with rubies.

We have spoken already of the colorless corundum, the white sapphire. It can be produced in very beautiful specimens, just as clear as water, which have exactly the same properties as natural stones, but are said not to equal them in luster and fire.

A very beautiful stone is the artificial yellow corundum which corresponds to the natural Oriental topaz or topaz-sapphire; the violet Oriental amethyst, the violet ruby, has also been reproduced artificially.

We shall deal a little more fully with the artificial production of the blue sapphire which, after the ruby, is the most important gem of the corundum family. In this case particular difficulties have been experienced in the application of Verneuil's method and real success has not been achieved so far. What is now sometimes called "synthetic sapphire" is not, as in the case of the ruby, an artificial stone having all the properties of the natural one, but a product which differs from the natural article materially in important points.

The blue coloring agent of the natural sapphire is not proof against the action of heat (like that of the ruby) but is destroyed thereby and for this reason is thought by many to be of organic nature. Accordingly in making artificial sapphires cobalt in the form of CoO has been resorted to as a means of giving a blue color to the molten alumina mass. But quite unexpectedly the molten drop at first absolutely refused to take any color. Even when an addition of 5 per cent of CoO was employed none of it became incorporated and the drop remained colorless. The coloring matter did not enter into the melt until a further addition of a few per cent of CaO or MgO was made to the mass and then even 0.1 per cent of CoO was sufficient to produce a very bright blue color. In this case however these slight admixtures of foreign substances produce the remarkable result that the molten drops consisting chiefly of Al_2O_3 do not form a unitary crystal after solidification (as they did in the case of the ruby, etc.) but they yield a glassy amorphous body having indeed the same external shape as in the case of the ruby, but no double refraction and no dichroism and a smaller hardness than crystallized alumina and also a smaller specific gravity (from 3.6 to 3.8 instead of 4). Physically considered it is therefore a substance totally different from corundum and comparable to quartz glass (fused quartz in its relation to rock crystals). In any event we cannot term this a synthetic sapphire in the sense defined at the beginning of this paper. The small contents of CaO, MgO and of the cobalt compound have evidently been sufficient to entirely destroy the crystal-forming capacity of the molten alumina, whereas in the case of the ruby the color-giving chromium compound is presumably admixed as Cr_2O_3, isomorphous with alumina and therefore does not hinder crystallization.

Even in external appearance this artificial product is far inferior to the beautifully blue natural sapphire. It is too strongly blue, of a hue no genuine sapphire will exhibit, it is the vulgar blue color of cobalt glass, smalt, and we miss the attractive velvety gloss of the natural crystallized stones. Furthermore, by lamplight the color turns to purple, which defect may indeed be avoided by a slight addition of iron. The conclusion is that a real synthetic sapphire does not exist as yet and for the reason stated above is not likely to be produced in the near future, at least not according to Verneuil's method.

There is, again, the so-called synthetic alexandrite. The genuine alexandrite is the dark emerald green variety of the mineral chrysoberyl another variety of which known as cats eye also has some importance among gems being distinguished by a peculiar wavy reflection of light The alexandrite is noted for its remarkable change of color In daylight only it will show an emerald green by lamplight it has a decided purple color Among the molten drops produced in accordance with Verneuils method and the stones cut therefrom there are some that exhibit a similar change of colors In daylight they appear light green under artificial light beautifully purple For this reason they have been considered artificial alexandrite or at least designated as such Careful analysis has shown however that these artificial stones contain no beryllium or at least very little of it that they have not the specific gravity of alexandrite (3 7) but that of corundum (4) and likewise that all other properties practically the optical ones are those of corundum and not of alexandrite We are therefore dealing not with alexandrite but with an artificial corundum and as a matter of fact there are in this group but only as specimens of extreme rarity some natural stones in which we observe a change of color similar to that seen in these artificial gems How the latter are made that is what coloring principle is used is entirely unknown

If we sum up the substance of the facts recited above we perceive that if we except the so-called synthetic sapphire Verneuils method is applicable at present only for producing gems of the corundum group as crystallized bottle-shaped molten drops The topaz and alexandrite cannot as yet be reproduced in this manner notwithstanding the suggestive names given to some of these artificial products

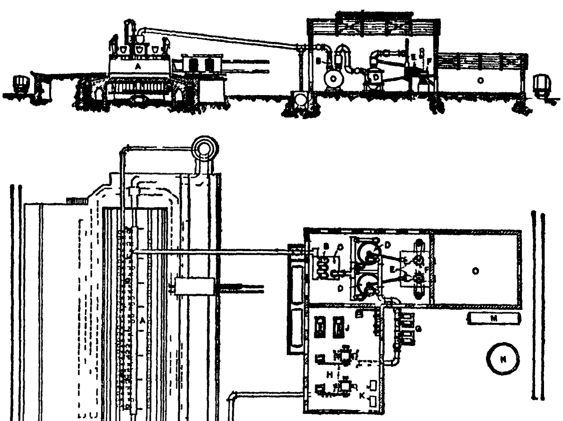
In connection with the above remarks I may refer to the so-called synthetic emerald The emerald is the fine green variety of the mineral beryl and in flawless specimens is about equal in value to the ruby in the list of precious stones What is called synthetic emerald and brought into the market as such is nothing but fraud Sometimes it is glass colored green with chromium sometimes so-called doublets The top of the cut stones and the bottom are colorless glass or rock crystal or aquamarine a variety of beryl of a light bluish green color and of no great value on account of its frequent occurrence Between the top and bottom there is inserted a thin emerald green plate of glass or of gelatine which when the stone is viewed from above gives it the same color in a perfectly deceiving fashion But if the stone is looked at from the side or otherwise examined closely the imitation will be discovered readily such examination however cannot be made when the stones are set Other similar combinations of worthless green and colorless parts have also been observed The manufacture of these imitations is also said to have its chief home in Paris The synthetic production of real emeralds has not been accomplished as yet neither has that of aquamarines or other varieties of the mineral beryl

In conclusion I shall mention the diamond but only to say that it has been produced in various ways in the form of very tiny crystals Such manufacture however has not so far acquired any importance for the trade in precious stones I therefore believe that I should not enter into the matter any further at this place

AMMONIA FROM COKE OVEN GAS.

ITS DIRECT PRODUCTION.

G Hilgenstock Dalhausen Ruhr Germany has an article in Stahl und Eisen on The Direct Production of Ammonia from Coke Oven Gas The following is an abstract made by the Iron Age with two of the illustrations used



FIGS 1 AND 2 PLAN AND ELEVATION OF AN INSTALLATION FOR THE DIRECT PRODUCTION OF AMMONIA FROM COKE OVEN GAS

The winning of nitrogen in the form of ammonia from coke oven gases was concomitant with the preparation of phosphorus in useful form for agricultural purposes The method laid down by Dr Otto in 1884 while improved and simplified still depends upon five distinct stages First the cooling of the gases by the air and water circulation next washing the gases with cold water to remove the last traces of tar and ammonia then separation of tar and ammonia water in large tanks through their specific gravities then the driving off of the ammonia by steam and added lime finally the condensation of the ammonia into a strong solution or else combination with an acid making a salt

This roundabout method has been and is used because we have not developed a shorter one It would seem possible to take the ammonia vapor as it comes from the ovens diluted only by gas into an apparatus and there complete the operation This supposition was based upon the working of the steam jet and the knowledge that tar itself is the best solvent for tarry vapor Experiments along these lines gave surprising results when the precaution was taken not to let the tar exceed 175 deg F and that no condensation took place The tar for washing was introduced by a steam jet and at the works where these trials were made it was perfected to a point where less than 45 grains remained in every 1 000 cubic feet of gas Credit should be given the firm of Franz Brunck which as early as five years ago passed the coke oven gases directly into concentrated sulphuric acid this at temperatures precluding condensation However many difficulties were encountered and the high temperatures and lack of solvents for the tar remained a detriment to the process for a long time Other methods involving several stages could have been applied but the one described herewith has given perfect satisfaction Experiments have shown that the very small quantities of condensation products which separate out with the tar contain practically only ammonia salts and these are returned to the gases in the saturation chamber with the steam Where there are occasional abnormal quantities of condensation products as for instance with very wet coal for coking provision is made to separate these gases from the drier ones

The first installation using the direct method for ammonia is in operation at the Julia Colliery of the Harpener Association Here the usual troubles of a newly introduced process were met with and overcome Even here from the very first a perfectly white sulphate of ammonia was obtained It had over 25 per cent ammonia and only a few tenths free acid The next installation was at the Vondern Colliery where everything has worked smoothly from the start the salt after centrifuging being perfectly white and containing 25 26 per cent ammonia and 0 20 per cent free acid After a short storage it becomes perfectly odorless

The accompanying illustrations give a plan and elevation of a direct method installation *A* shows the coke ovens In the tar jets *B* a very intimate mixture of the tar and gases takes place so that when the tar catch basins *C* are reached the gas is free from the tar The tar pumps *J* supply the jets continuously and the product caught in *C* is carried into storage tanks The hot gases after the tar separation and containing all the water vapors and ammonia are led into the absorption tanks *D* which are closed and in which there is the necessary sulphuric acid The reaction between ammonia and acid is sufficient to keep the temperature up to a point giving proper results the sulphate of ammonia drops to the bottom after sufficient saturation and is carried upon the drainage platform *E* by means of an ejector in the usual way The centrifugal machines *F* dry it and it is then carried to the storage *O* The mother liquor from the draining platform is returned directly to the absorption tanks

The gas is now dried passing through the condensers *G* fed by pumps *K* in the usual way The gases pass to the benzol extraction apparatus and thence to the coke ovens for firing or else into gas tanks for city lighting At *M* is the acid tank and at *N* the tar shipping tank

The advantages of the direct process are obvious The washing and distilling apparatus is done away with steam is saved settling ponds and removal of slimes are no longer necessary and the operation is simple and cheap

* * *

Warm-blooded animals possess fundamental means of protection against foreign substances which have invaded the organism To the entrance or formation within the body of bacterial or other poisons the organism responds by the production of specific antidotes or antitoxins while it reacts to the invasion of living bacteria by producing special solvents or lysins These natural safeguards which are collectively called alexins are at the disposal of warm blooded animals in a normal state of health and upon their presence depends the germicidal power which the cells of the body normally exhibit The leucocytes or white corpuscles of the blood are concerned in the production of these antidotes The well known fact that fresh water crabs possess very little power of resistance to the attacks of bacteria so that an infectious disease almost annihilated the crabs of Europe in a short time suggests the question whether cold blooded animals possess these natural means of protection Investigations made by Angerer at the Biological Experiment Station of Munich have shown that the blood of fishes (carp) exhibits a powerful germicidal action upon typhoid bacilli and other bacteria which are devoured and digested in great quantities by the white blood corpuscles by the process which Metchnikoff calls phagocytosis Many experiments on crabs have confirmed the prevailing assumption that the blood of these crustaceans possesses only a very small power of producing bactericidal substances The blood of snails and mussels is also very nearly destitute of bactericidal power while on the other hand the slimy mucus exuded by hibernating snails possesses a strong germicidal power The May beetle also appears to be very well protected by nature This contrast between fishes and snails, crabs and May beetles proves that the thickness of the external armor stands in no relation to the power of the organism to protect itself against bacteria, and also that the armor does not prevent the entrance of bacteria.

VARIOUS TYPES OF SAFETY LAMPS.*

A CONSIDERATION OF THEIR COMPARATIVE SAFETY.

BY J. B. MARSAUT.

Since Davy nearly a century ago constructed the first safety lamp almost innumerable inventors have produced lamps bearing their names but in a majority of instances the alleged improvements have been more apparent than real At various times commissions have been appointed and are still maintained by several of the European governments to pass upon the safeness of safety lamps one of the earliest being the one headed by Le Chatelier in 1889 After pointing out a few general conditions I shall outline the progress in the development of those lamps that were approved by Le Chatelier and then describe a few of those that have appeared since that time and have been tested with satisfactory results

PRINCIPLES OF THE SAFETY LAMP

It has long been known that the Davy and all other lamps in which the flame is protected by one or even two gauzes without an outer mantle are not safe in a current of inflammable atmosphere blowing with a velocity of 2 to 4 meters per second in such a current combustion of gas will begin inside the lamp will heat the gauze to redness and will then transmit the combustion outward to the surrounding atmosphere This knowledge has been gained both by experiment and by the sacrifice of innumerable lives If likewise a lamp of this simple type should become filled with an explosive mixture the detonation that would ensue inside the lamp would often suffice to blow the flame outward and cause an explosion This phenomenon is the more likely to occur if the interior volume of the lamp is large in proportion to the area of the surrounding gauze A relatively large gauze is therefore conducive to safety

My experiments have pointed to a number of other interesting details For example in a lamp having a glass cylinder surmounted by a gauze mantle an interior explosion is the more violent as the flame of the lamp is the smaller This is because the amount of inert gas present in the lamp as a product of wick combustion is small Thus a large flame increases the safeness of a lamp of this type contrary to the common opinion Fortunately it is not easy to fill a lighted lamp with a perfectly proportioned explosive mixture of gas and air but such a contingency is within the realms of possibility

Working in a testing laboratory with artificial air and gas mixtures and exploding them at will by an electric spark the following phenomena are readily observed (*a*) In the Clanny Marsaut and other lamps having a glass cylinder surmounted by a wire gauze an explosion is the more violent as the point of ignition approaches the bottom of the glass The height of the glass should thus be as little as is consistent with satisfactory illuminations (*b*) With mixtures of illuminating gas and air transmissions of combustion through even two gauze mantles are common three concentric gauzes however seem to suffice to restrain such transmission ( ) The frequency of transmission of flame through the gauze of a safety lamp of the type described above is still more apparent if the diameter of the gauze mantle is less than that of the glass cylinder or if the space within the gauze is obstructed

Although natural firedamp is much less dangerous than carefully adjusted mixtures of air and illuminating gas such as are used in a laboratory the fact remains that the results attained by experiment should be borne in mind while designing safety lamps that is the height of the glass cylinder should be reduced to the lowest limit the interior should have a cylindrical or very slightly conical shape and all obstructions to the quiet circulation of currents within the lamp should be avoided

Among the large number of safety lamps extant in 1889 there were really only a few distinct types and of these LeChatelier recognized only six the Davy Clanny Mueseler Marsaut Fumat and Gray lamps besides the electric light which at that time was still in the experimental stage

DAVY AND CLANNY LAMPS

Both of these lamps in which the wire gauzes are not protected by any kind of exterior mantle have long since outlived their usefulness as affording only a slight degree of safety The inventor of the Clanny lamp, by inserting a glass cylinder at the base of the gauze increased the illuminating power of the flame and at the same time though he was possibly unaware of it, introduced another marked improvement, the downward draft, whereby a gaseous atmosphere would generally extinguish the flame and thus serve as a warning The gas might however continue to burn inside the gauze when the Clanny would then have all the dangerous features of the Davy lamp Lamps of these two types have long been interdicted in France and Belgium though under the name of Wolf they are in almost exclusive use in Germany

MUESELER

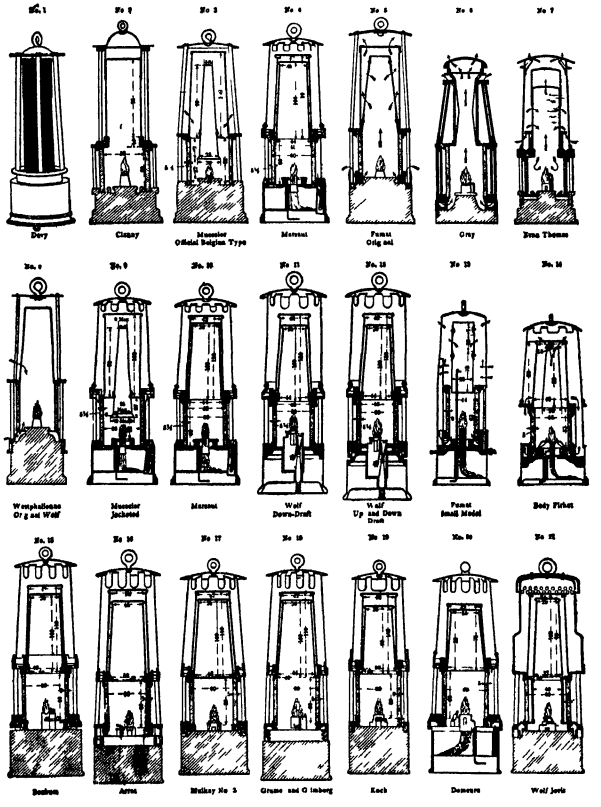
The Mueseler was like the Clanny lamp with the addition of an interior chimney supported by a metallic diaphragm at the level of the top of the glass cylinder These parts were expected [illegible] [illegible] reason of their remaining filled with inert gas to prevent combustion of inflammable gas inside the gauze access of firedamp would cause a small explosion in the base of the lamp whereby both the lamp's flame and the burning gas would be extinguished It was found however that a turbulent current of inflammable gas might sometimes upset the natural draft of the lamp filling the chimney with an explosive mixture which then acted as a fuse to conduct the combustion to and through the gauze An excess of gas also by incomplete combustion within the lamp might yield an amount of carbon monoxide capable of transmitting the flame to the exterior

In an atmosphere of illuminating gas it has been found quite possible for the interior combustion to pass through the diaphragm and even to the outside In spite of these deficiencies, the use of the Mueseler lamp remained obligatory in Belgium until the tests of Watteyne and Stassart at Frameries in [illegible] proved its inferiority The construction of the Mueseler lamp especially as to the thoughtfully designed dimensions of the glass cylinder and the method of mounting this in copper rings is highly to be commended

MARSAUT

The Marsaut lamp borrows the dimensions the oil reservoir the thick glass and the method of mounting found in the Mueseler lamp but instead of the interior chimney and diaphragm has a small [illegible] gauze inside the [illegible] [illegible] and a metallic jacket or mantle outside of both The double mantle permits the rapid escape of the products of an interior combustion of gas while the jacket protects the lamp from drafts of explosive atmosphere and from breakage When tested in an atmosphere of illuminating gas and air three gauzes are found to be necessary to insure the isolation of an interior gas combustion but in the ordinary atmosphere of a gaseous mine two gauzes have been proved beyond question to be adequate

English tests of the Marsaut lamp with two gauzes and a jacket by maintaining a gaseous current of 20 meters per second velocity directed continuously against the lamp have succeeded in causing a transmission of combustion outwardly but in these tests the lamp was transformed into a miniature furnace which melted the gauze a condition which would never be realized in a mine In these same tests



LEADING TYPES OF SAFETY LAMPS

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* Abstracted from the Bulletin de la Société de l'Industrie Minérale, March, [illegible].

however, a lamp with three gauzes proved entirely safe. The Belgian commissioners in their report in which they condemn the use of the Mueseler lamp in distinctly gaseous mines make the following statement as to the Marsaut: "The Marsaut lamp with vegetable oil withstood all tests both with and without dust, both new and old lamps being tested; the Marsaut lamp with benzene, although it became heated, withstood all tests for the passage of combustion through the gauze."

FUMAT AND GRAY LAMPS

The Fumat lamp was designed to obviate the possibility of explosions within the lamp by causing an inflammable gas to burn as rapidly as it enters. This was accomplished by reducing the diameter of the glass cylinder. A solid metal cylinder covered by a gauze cap was put outside the usual wire gauze. Upward draft was provided in order to improve the illuminating power. This lamp did not prove satisfactory and was superseded in 1900 by a smaller model in which the current of air is introduced into the lamp through a small metallic duct leading from near the top of the lamp down to the vicinity of the flame. This accomplished about the same result as the Gray lamp but without interfering so much with the illuminating power, since the large tubes through which the air is conducted into the Gray lamp cast rather large shadows. Neither of these two lamps has come into general use.

THE WOLF LAMP

The Wolf is the most common of the lamps that have come into use since the time of LeChatelier's investigations. It has acquired its present form by gradual improvements. The first step was to substitute gasoline for heavy oil in the ordinary Westphalian lamp. This came into quick favor in Germany, but the backwardness of French miners to accept gasoline for the illuminant compelled other improvements. The Wolf lamp first took on two gauzes, then a metal jacket, becoming, though not appreciated by Wolf, the same thing as the Marsaut lamp. A further change was introduced by causing the air to enter both from above and below the glass.

As with all lamps drawing their air from below, an inflammable gas will burn inside the Wolf lamp, heating the oil reservoir sometimes to the danger point and frequently cracking the glass. The illuminating power of the Wolf lamp is certainly better than that of some other lamps, but it is well known that the security of a safety lamp is inversely proportional to its candle power. It seems to me that the points of the Wolf lamp to which credit is chiefly due are the use of gasoline instead of heavy oil and the admirable relighting and locking appliances which were designed to go with the lamp.

BODY FIRKET

Among the lamps approved by the Frameries investigators is the Body Firket. This resembles the Fumat in respect to the admission of air, while its interior arrangement is like that of the Gray lamp. It has the Upton and Roberts shield for protecting the glass from the flame of an internal combustion of gas, which is a very valuable adjunct to any lamp deriving its air from below. The lamp has only one gauze and one jacket, while the interior cylinder affords all the disadvantages referred to above in discussing the Mueseler lamp. Its illuminating power is also deficient.

RECENT LAMPS

As a result of the long investigation at Frameries the following lamps were permitted in Belgian mines under regulation as to their shape and size: Mueseler (jacketed), Marsaut, Wolf (with either up or down draft), Fumat (heavy oil only), Body Firket (heavy oil only). The Frameries commission put no restraint on the invention of new lamps, and as a result at least seven new lamps have been authorized since 1904. They are the Bochum, Arras, Mulkay No. 2, Grümer & Grimberg, Koch, K[illegible] and the Wolf No. 3. An examination of the first six of these lamps shows them to be only slightly modified types of the Wolf pattern, differing among themselves only in the method of baffling the entrance of air. Some of them have less illuminating power than the Wolf lamp, and it is hard to see any reason for their existence. The Wolf No. 3 lamp invented by H. [illegible] is smaller and lighter than many others. It has a double glass cylinder, being to this extent more complicated than its prototype. Double glasses have been tried before, but without affording any marked advantage.

GASOLINE VS. HEAVY OILS

Gasoline has now for a long time been permitted in German mines as an illuminant, and its use is coming more and more into favor in France and Belgium. It has the advantage of yielding a brighter light, but many engineers are still uneasy as to its safety. The defects of gasoline for this purpose are more or less grave. Lamps burning benzene get hot quicker than those burning oil, especially in a gaseous atmosphere, and the glass cylinders break more frequently. To obviate these difficulties the lamps have to be made more bulky and heavier, while at the same time the thickness of the glass has to be diminished, so that if one should take hold of a hot lamp by mistake and drop it there would be danger of breaking the glass and causing an explosion.

In certain kinds of work in which a lamp is subjected to a good deal of jolting, a gasoline lamp goes out more frequently than an oil lamp, and the handling of gasoline requires greater caution than that of oil. It is possible to get better illumination out of an oil lamp by enlarging the gauze mantle and making the lamp bigger, but this has corresponding drawbacks. The argument that lamps of high illuminating power decrease the danger of falls from the roof by enabling the workmen to discover sooner the symptoms of caving ground seems to me to be not well demonstrated, which opinion is shared by the eminent engineer Harzé, the Belgian director general of mines.

AIR DRAFT AND RELIGHTING

From the preceding descriptions it will have been noticed that in some lamps the air is admitted from above the flame, in others from below, and in others from both directions. Each method has its own effect on the illuminating power of the lamp, but they are not all equally safe. The object of the downward draft is to keep the lamp filled more or less with a volume of inert gas to the exclusion of any possible explosive mixture; only in exceptional circumstances can a perfectly explosive mixture make its way into such a lamp. With an upward or a mixed draft, on the other hand, the lamp, sometimes highly heated in a gaseous atmosphere, acts as a chimney in drawing inflammable gas upward into the chamber; if the light should go out the gaseous mixture would still circulate, expelling the inert products, and might end in the accumulation of a perfectly explosive mixture within the lamp.

If now a relighter should be put into operation an internal explosion would ensue, which would probably be conducted to the exterior. The rules of France and Belgium forbid the relighting of a lamp that has been extinguished by a fall, a blow, or any accident that might cause a rent in the gauze. German regulations prohibit the relighting of a lamp at any place in which an accumulation of gas is suspected, but if a lamp is provided with a relighter such rules as these are of little effect. In my opinion it would be wise to forbid the use of a relighter in any lamp not having downward draft alone. A downward draft lamp is thought to be somewhat less easy to relight than one with an upward draft, but German experience does not support this idea.

LOCKING OF LAMPS

The locking device is not an essential feature of the safety lamp, but it assists greatly in assuring the safety for which the lamps have been designed. Many inventors have attacked the problem, and it may now be considered as satisfactorily solved. We have a choice of several different but equally effective methods, some of which are very ingenious, as Cuvelier's hydraulic lock, the magnetic lock originated by Villiers and improved by Wolf, and the lead rivet lock.

Personally I prefer a lock consisting of a large lead rivet which shall be easily felt and visible to the naked eye. A group of miners supplied with lamps [illegible] this kind of a lock, if barricaded behind a fall of roof, could make their joint supply of oil last a great while.

THE OLDEST NEWSPAPERS

During the Roman empire the publication of newspapers had already attained a certain vogue, and if a few numbers of the official daily record which Cæsar prepared with the assistance of many thousand writers and distributed over the whole cultivated world of his time had been preserved for us, we would be much better instructed today in regard to the daily life of those days. The Acta Diurna Publica gave reports of the splendid public festivals, of the military campaigns and victories, of social and literary events, and of piquant adventures. The oldest of all the newspapers that still exist today, the first printed newspaper of the world, is the Chinese publication the King Pao, that is, the Chronicle of the Capital. It is said to have been founded in the year 911 of the Christian era, but appeared regularly only in and after 13[illegible]1. For four centuries it was published every two weeks and since 1800 every day. To-day it is published three times a day, and its three editions are printed on different paper, the morning edition on yellow, the noon edition on white and the evening edition on gray paper, to avoid all confusion.

The origin of the first European newspaper is still in a mist of uncertainty. In obedience to circumstance certain coteries and societies were formed as centers for which much important information was acquired and then distributed in directions suited to a specific purpose. Thus in Germany the Fugger trade office in Augsburg, which in its writing rooms gathered all kinds of important news, and for a yearly assessment distributed them to all those who had a definite desire for them. Besides these Fugger written newspapers, so-called versatile men composed newspaper letters. The Emperor Rudolph II, for instance, paid two hundred florins in gold every year to a man in Cologne who wrote him regularly a chronicle of the events in France and the Netherlands. Out of these written newspaper letters were then developed the printed newspapers in the years of the narrow interval that immediately preceded the seventeenth century. The Austrian Michael von Aitzing must be regarded as the founder of the modern German newspaper method. In 158[illegible] he sold at the Frankfort fair a quarto edition of the Cologne Transactions relating negotiations which had been conducted between the Pope and the Elector Gebhard. As this periodical always appeared during the Frankfort fair, it was also called the News of the Fair, acquired great popularity, and soon was confronted with various competitors. This News must have been followed soon by the German real newspaper, of which the earliest volumes cannot be shown, and the only early volumes extant or accessible are a volume of the newspaper published in Strasburg in 1609 and a volume of a newspaper published in Augsburg in the same year. The title of the Strasburg newspaper, ample and crudely, sometimes grotesquely spelled after the manner of that day, was:

"Relation of all that may occur and all the noteworthy news that may be heard now and then in Upper and Lower Germany, also in France, Italy, Scotland and England, Spain, Hungary, Poland, Transylvania, Wallachia, Moldavia, Turkey, and so forth in this 1609 year, all of which I will put in print in the most faithful manner just as I receive it."

The oldest English newspaper first appeared in the year 1622, while the reports of the English Mercury attributed to the year 1588 are now known as forgeries. The first French newspaper was founded by Théophraste Renaudot, a physician, and it was he who projected the first labor bureau. The title of the newspaper was La Gazette, and was so called after the small Venetian coin which was the price of the written newspapers that had been bought formerly on the Rialto. This paper appeared for the first time on the 30th of May, 1631, and its whole extent was four pages. Since 1762 it has been called La Gazette de France, and is published at the present day.

The correctness of the assertion that La Gazette de France is the oldest French newspaper is contested in a recent issue of the Boersenblatt fuer den Deutschen Buchhandel, a bulletin published by the German book trade, with the following statement:

The founder of La Gazette de France, Théophraste Renaudot, had already a long time previously begun the publication of Les Petites Affiches, which is still published to-day and is now a mere advertising medium. The original purpose of this paper was the publication not only of advertisements, but of opinions and news regarding private individuals who themselves had an interest in the dissemination of them.

But even Les Petites Affiches was not the oldest French newspaper really. The merit of having published the oldest one is due to Charles VIII. When he in August, 1494, led his army into Venice and in the following year conquered the kingdom of Naples, he published a regular periodical report of the progress of his campaign, which was essentially a newspaper.

In regard to the aforementioned La Gazette de France, its original title was the simple name Gazette. Théophraste Renaudot introduced this name from Venice. One stage of a journey he had made was the city of the Doges. While in this city he caught sight of the oldest Venetian newspaper, a public print that contained reports of municipal affairs and general news, and was sold for a gazetta, an old Venetian coin having, say, a value of two cents. And the name of the coin was the title of the paper. Renaudot promptly conceived the idea of giving to his own paper the same title. La Gazette de France was sold in the streets and was greeted with a most satisfactory demand. Certainly it was Renaudot who provoked the first phase of the marvelous vogue with which the French newspapers have been rewarded—Renaudot the first French journalist.

The Gazette had celebrated collaborators indeed. A few of them, for instance, were Louis XIII, Cardinal Richelieu and his wily assistant, the Capuchin monk François Leclerc du Tremblay. The editorial staff consisted of Renaudot and his sons Isaac and Eusebius. Later Renaudot was the representative in the Gazette of the policies of Mazarin, the successor of Richelieu.

It should be stated that the first real daily newspaper published in France was the Journal de Paris, which was founded in 1777.

* * *

Synderamine Paint.—Grind 10 parts of finely pounded graphite, 10 parts chalk, 30 parts of heavy spar and 15 parts of well dryed linseed-oil varnish to a paint of the consistency of ointment. Before use the paint should be diluted with a suitable quantity of linseed-oil varnish.

ASTRONOMY AND ASTROLOGY.

THE DEVELOPMENT OF ASTROLOGY.

BY F W. HENKEL, B.A., F.R.A.S

From the earliest times down to the last two centuries no very clear distinction was made between astronomy and astrology The former was often designated 'natural astrology dealing with the movements and appearances of the heavenly bodies the latter was called judicial astrology and dealt with rules for determining their supposed influences upon terrestrial affairs the destinies of individuals especially of those highly placed in office There seems little reason to doubt that it was a desire to know the nature of this supposed influence especially as affecting themselves personally that led to the patronage of the science by rulers Astrologers were attached to the courts of the principal princes of Europe during the Middle Ages and such astronomical work as they were allowed to perform was often undertaken with this end in view Astronomy would starve exclaimed Kepler on one occasion were it not for her harum scarum daughter Astrology He himself the illustrious discoverer of the three great laws of planetary motion Imperial Astronomer and Mathematician to the Emperor Rudolph was obliged to eke out his irregularly paid stipend by the money he earned from casting horoscopes and *fortune telling by the stars* *Lord Bacon* sometimes though with little justice considered the father of the inductive method was a believer in a form of astrology though he suggested that inquiry was necessary to determine the just rules of the *Astrologia Sana* In Shakespeare we find references to the belief in the influence of the stars on human fortunes In Henry IV we find Glendower saying At my nativity the front of heaven was full of fiery shapes of burning cressets Chaucer alludes to the evil effects produced by Saturn

quoth Saturn

My course that hath so wide for to turn
Hath more power than wot any man
Mine is the drenching in the sea so wan
Mine is the prison in the dark coat
Mine is the strangling and hanging by the throat
The murmur and the churls rebelling

Each planet had assigned to it a particular metal and a distinctive color often no doubt suggested by its hue

Sol gold is and Luna silver we threpe
Mars iron Mercury (quick) silver we clepe
Saturn lead and Jupiter is tin
And Venus copper by my faderkin

(Canon s Yeoman s Tale Chaucer)

The colors by a more or less obvious analogy were thus assigned to the sun and planets Yellow to the sun azure blue to Mercury red to Mars black to Saturn etc The mediæval astrologers also assigned colors to the twelve signs of the zodiac and particular districts were ruled over by each sign thus Aries ruled over England France and Denmark Taurus over Ireland Holland and Persia The sign Gemini in particular was regarded as especially associated with the fortunes (or misfortunes) of London and accordingly the plague the great fire of London and the building of London Bridge were all associated with the position of this sign

Lilly the astrologer is credited with having predicted the occurrence of the plague of 1665 and the great fire of 1666 which latter occurred at the time when part of the sign Gemini was in the ascendant of London He was questioned by the House of Commons committee appointed to inquire into the cause of the fire and declared that he had discovered by his art that such an event was to happen but disclaimed any knowledge as to its date or cause It is not difficult to understand how some of the influences assigned to the heavenly bodies came to be attributed to them Thus the sun from his very evident influence on all terrestrial phenomena and the moon from her tidal action being known to be potent factors the idea naturally arose that others of the heavenly bodies might have powers as great as or even greater than these two over man s destiny The fiery red color of Mars seemed naturally to associate this planet with wars and rumors of wars the dull luster and slow movements of Saturn as naturally indicated misfortune and Saturnine influence while the brilliancy of Jupiter and Venus led to their being considered fortunate planets Mercury too always close to the sun and difficult to detect from his rapid motions betokened volatile and choleric temperament Yet how the astrologers came to devise the elaborate system by which every planet and each sign has its special influence is by no means easy to say

In Whewell s opinion the sun moon and planets being identified with the gods and goddesses of the Greek and Roman mythology (still surviving in the names of the days of the week) the characters assigned to these deities were transferred to the stars bearing their names Others there are who with equal probability consider that these mythological beliefs were suggested by astrological ideas the character of Mars from the red color of the planet of that name the swift footed Mercury (messenger of the gods) from the rapid movements of the planet and the supremacy of Jupiter from the greater brightness of that star and so forth Nevertheless though the belief in astrology was very general until quite recent times there were always clear minded thinkers who shook themselves free from the popular superstition Shakespeare in King Lear says This is the excellent foppery of the world that when we are sick in fortune we make guilty of our disasters the sun moon and stars as if we were villains by necessity fools by heavenly compulsion knaves thieves and treacherous by spherical predominance etc

In earlier times Cicero (De Div II) reasoned with sound judgment against the belief in astrology The Emperor Vespasian when told that his courtiers were discussing the prodigy of the appearance of a comet said This hairy star does not concern me it menaces rather the King of the Parthians for he is hairy but I am bald Similarly Henry IV of France speaking of the astrologers who had foretold his death is said to have exclaimed They will be right some day and the public will remember the one prediction that has come true better than all the rest that have proved false Bayle has well said The more we study man the more it appears that pride is his ruling passion and that he affects grandeur even in his misery Mean and perishable creature that he is he has been able to persuade himself that he cannot die without disturbing the course of Nature and obliging the heavens to put themselves to fresh expense to light his funeral pomp Foolish and ridiculous vanity If we had a just idea of the universe we should soon comprehend that the death or birth of a prince is so insignificant a matter compared to the whole of Nature that it is not an event to stir the heavens

Yet other writers from time to time allude to the fancies of the astrologers and though it seems wonderful how so extraordinary a mass of unsupported conjectures and absurd notions could ever have been seriously regarded as science still we must not look upon the work of these early zealots as altogether vain and wasted

Just as the fruitless search for the elixir of life and the philosopher s stone by the old alchemists (themselves often astrologers also) laid the foundations of the modern science of chemistry so by the watching of the early astrologers was accumulated the material whereon their successors have built the mighty superstructure of modern astronomy Though it is and probably will remain far beyond our power to predict the future course of human affairs yet the astronomer can determine the future positions of the planets of our system for many ages to come with a precision greater than that of many actual observations Halley s comet whose return we have just witnessed has been detected almost in the position assigned by calculation after an absence of seventy four years (of invisibility) during which time it has receded to a distance of more than three thousand millions of miles from the sun The past and future history of the earth s path round the sun is known for a million of years on either side of the present time From the observations of the *early Chaldean astrologers and their records of eclipses* the theory of the moon s motion has been and is being perfected

So long as the earth was regarded as the center of the universe and the sun and stars merely secondary orbs of no great size moving round it there seemed little to wonder at in man s faith in the teachings of astrology though even then one might ask how the special influences assigned to the various heavenly bodies were ascertained to belong to them with such minuteness

*If a man s future career depended only on the posi*tion of the heavenly bodies at the time and place of his birth how did it happen that of two persons both born at the same time and place one became a beggar the other a monarch? How different for instance the careers of the twin brothers Jacob and Esau and how different their temperaments! When we consider the earth as it really is a small planet moving round its central sun together with its fellows some approaching it in size others greatly surpassing it and that there have since been discovered two great planets and a number *of moons quite unknown to the early astrolog*ers it seems hard to conceive our planet to be of such importance that all these other bodies merely exist for its benefit or rather for that of its inhabitants Our sun too though all important to us is only a cadet among the hosts of heaven and there are stars probably as far surpassing it in magnitude as itself surpasses the earth Knowledge

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GIGANTIC ABYSS IN THE GREAT NEBULA IN ORION

By Edgar Lucien Larkin

The beneficent patron of astronomy Mr John D Hooker of Los Angeles Cal now has on display some wonderful photographs These were made in the Mount Wilson Observatory and are of the central regions of the Orion nebula The original negatives have been greatly enlarged on transparencies All these are now set in movable frames in an ingenious mechanism for display Each plate is set in front of sixteen incandescent electric lamps arranged in a square whose dimensions are the same as those of the photograph to be shown about fifteen inches on a side The room is darkened the observer stands before the apparatus at distances of from ten to twenty feet When the sixteen lamps are lighted a marvelous effect is obtained The central portion of the Huyghenian region in the nebula of Orion is the opening of a colossal cavern in the primordial stellar floor In these pictures the nebula is no longer a flat surface. One peers within cosmic deeps; looks into a chasm before which all powers of imagination are submerged, and feasts the eye with supernal splendors Every appearance is that of looking in at a door and to the rear of the cave deep within glittering nebulosity The impression made is that the rear walls of this cavern are at an inconceivable distance back from the opening Mr Hooker has had all the adjacent regions separately photographed and shows these in succession round and about the cavern s mouth Then he again puts this on magnificent display The impression that one is peering into an abyss is confirmed and strengthened This chasm as seen in these pictures is the most beautiful object in the possession of man Pillars columns walls façades bulwarks stalactites and stalagmites are within deeps of deeps These glow and shine superbly with pearly light

The nebula has no parallax capable of being measured Adjacent stars have been observed those having proper motion and those in revolution around their common centers of gravity Mass times and motions have been made use of to deduce parallaxes These range between the one three hundredth and one two hundredth of one second of arc To be within bounds let estimates of the cave s dimensions be made on the basis of one two hundredth Then the nebula if at the same distance of the neighboring stars at once becomes of colossal magnitude None is able to begin to think of the dimensions The central region of the nebula may be taken as of the angular diameter of the moon or half of one degree The ragged torn and twisted edges of the openings as shown in Mr Hooker s transparencies for purposes of computation here will be taken as inclosing a space whose diameter is one fourth degree or 15 min Go to the cavern s mouth turn and look this way or toward the sun It would look in a great telescope like the point of a fine needle or a tiny piece of diamond dust The earth could not reveal its existence nor the distance from the earth to the sun a line 92 000 000 miles in length viewed from a point at a right angle It would fill an angle of one two hundredth part of a second Then 1 second would have a real length of 18 600 000 000 miles 1 min of 1 116 000 000 000 miles and 15 min of 16 740 000 000 000 the diameter of this stupendous opening in the stellar floor The judgment of the eye in this perspective is that the rear of the chasm is three times more distant than the width of the mouth If so—it actually is and more then the star pointed wall is 51 000 000 000 000 miles beyond the open door This is the distance of the star Sirius Hundreds of thousands of solar systems like ours could enter and have an abundance of space for free motion

But the nebula may be more distant than these stars. Then all these dimensions would be largely augmented. The spectrum of this giant mass reveals that it is gaseous. But how does gas emit light cold light in frigid space? Light without heat within a body of gas when space without is at the absolute zero of temperature is indeed a mystery. A firefly may be able to explain. Celestial photography as now conducted at the Yerkes Lick and Wilson observatories is a science whose coming achievements will no doubt be more and ever more astonishing. Light moves with the unthinkable velocity of 186 380 miles per second. With a parallax of one two-hundredth of one second the time required for light to reach the earth would be close to 600 years and 1 000 years with one three hundredth approximately. But what processes are in activity within Orion's cave of unfathomed depths? What suns and worlds are being formed? The second great plate of glass for the new 100-inch mirror presented to the Wilson Observatory by Mr Hooker has not yet arrived from France the first having been rejected on account of flaws.

THE THOUSANDTH ANNIVERSARY OF AN ARABIAN UNIVERSITY

The University of Cairo the most celebrated of all universities of the Mohammedan world can boast of having reached its thousandth anniversary. The recent preparation made for the celebration of this event was most noteworthy and shows to all other peoples interested the venerable duration of the scholastic endeavor in the culture of Islam. The very days in which this university was founded are also the date of the origin of the earliest scholastic foundations of Europe and these indeed were like the celebrated high school of Salerno for instance under Arabian influence also. But the University of Cairo provokes keen interest for the further reason that it holds before the eyes of the rest of the world a genuine oriental picture. The seat of this university is to-day in one of the oldest mosques of Cairo in the magnificently constructed Gami el Azhar and has been there since the year 988. Indeed if Arabian erudition once had the power to fructify European mental life to-day that power seems to have lapsed into the rigor of death long ago. Arabian erudition and the religion of Mohammed are still to-day very nearly identical the Koran constitutes the sole source of all wisdom and the schools are held in mosques or adjuncts.

In El Azhar as one thoroughly skillful observer describes it the room for prayer of the mosque is also the lecture room of the university. Its floor is covered with mats and the students enter this holy room only in their bare feet. In the great court in the halls of the sanctuary of the mosque the students sit on the floors in oriental fashion in groups around their teachers while with shoulders swaying they learn their lessons with a loud voice or murmur their prayers in accordance with the precepts of Islam. Whenever the word Allah occurs in the Koran the student must incline his head. The hours of instruction are divided among grammar religion law logic rhetoric and declamation of the Koran. Though the general aspect of the instruction is severely religious great tolerance prevails among the various phases of Islam here seeking together peacefully accommodation and instruction.

The number of students is very significant to say the least. Six years ago for instance it was 8 000 and was composed of Mohammedans from every part of their world. Here the Mohammedan students from India meet those from West Africa the Turk meets the Persian and the Arabian the inhabitants of Turkestan. The university is maintained by endowments which are very considerable. Every day more than [illegible] 000 loaves of bread are distributed among the students. Besides they are invited to free tables in restaurants and boarding houses and there are also lodging houses in which free accommodation is proffered them. The teachers are paid very meagerly and must depend also on other occupation beyond the schools for their shelter and sustenance. On the other hand the Sheik ul Islam the rector of the university enjoys a very large income. All these circumstances point to an old culture but they also show us a world that is already rigid from sheer peculiarity and so the millennial festival of the venerable and celebrated high school of Cairo is far more a festival that regards the past than one that predicts a luminous future.

The Electrical World illustrates an electric heater for drying the matrices used in newspaper printing and states that the close control of the temperature obtained with electric heating the rapidity with which the drying is effected and the technical excellence of the mats thus dried are strong points in favor of the method. Further as the electric heater can be applied exactly where it is wanted the room is not heated as with gas or steam and the electric process is more economical than any other. Printers' electricians on this side of the water may take a hint from this.

SCIENCE NOTES.

The chief center for the manipulation of semi-precious stones in Germany is in the Rhine Province. Both at Oberstein and Idar an important industry has been created which had its inception in the cutting and dyeing of native agate the chief deposits of which are now exhausted. At present imported stones are handled chiefly those coming principally from England and South America. Although agate only was dressed and colored in the early years of this industry at present all classes of stones are prepared for market. In this however the art consists not only in forming the rough stone but in giving it color as well.

Continuing their researches as to the action of ultra-violet light upon microbes P Cernovodeanu and V Henry of the Paris University recently presented the following account to the Académie des Sciences analyzing the different physical and chemical factors. Using powerful mercury vapor lamps in quartz tube the liquid was placed in vessels under the lamp at various distances and samples were taken out at intervals for testing. As the percentage of microbes has little influence they used emulsion of 10 000 to 100 000 microbes per cubic centimeter with Bacillus coli typhus cholera dysentery and others. The microbe destroying action decreases more rapidly than the square of the distance. The *220* volt lamp is for short distances five times as active as the 110 volt lamp and this is still more noticeable at greater distances. With the larger lamp the time needed to destroy all the coli bacillus is 4 seconds at a distance of *20* centimeters (82 inches). At 10 centimeters it is about one second. Regarding the depth of the liquid the action is even stronger with a thicker layer say of 10 inches than with but one inch. The speed is the same at temperatures of 0 to 55 deg C and the effect is produced even with a frozen liquid. Absence of air or oxygen has no effect. It is known that ultra-violet rays tend to form hydroxyl in water and this latter will destroy microbes. Such is not the effect here however as the amount of hydroxyl now formed is infinitesimal and would need to be 400 times as strong in order to destroy the coli bacillus. Different microbes do not show the same sensitiveness and we have the cholera microbe destroyed in 10 seconds while the tetanus bacillus needs from 20 to 60 seconds. As to wave length the spectrum of the mercury vapor lamp has a great number of ultra-violet rays which extend as far as *2 224* and lie between this and 3 908. A 1 2[illegible] inch glass plate stops off all these after 3 02[illegible] and the microbe destroying effect is now extremely slow 3 to [illegible] hours compared with 15 to 20 seconds. A 0 04 inch mica sheet has about the same effect. Protoplasm liquids such as albumen gelatin serum etc also absorb the rays and it is the rays which are absorbed by the protoplasm of the cells which have the destroying action.

In the Royal Society's Proceedings Messrs B D Steele and K Grant describe two types of micro-balance the more sensitive one having been constructed with the idea of measuring the amount of radium emanation given off by radium bromide and is sensitive to 1×10^{9} grammes. The second type of balance is for the absolute determination in weight up to 1/10 gramme with an accuracy of 10^{7} grammes. The cases of both balances were made of ⅛ inch brass tinned inside and out. In each case there is also connected a manometer and a two-way stop-cock so that communication can be made either with atmosphere or with a Geryk vacuum pump. The beams of both balances were made entirely of quartz in the form of a double triangle the more sensitive one having a mass of 0 1[illegible] gramme. To the beam is fused a concave quartz mirror and the position of equilibrium is determined by means of the lamp and telescope method. To prevent disturbances due to heating the Nernst lamp used is placed in a metal case and the light is passed through a hole in it and through a solution of alum. Irregularities in behavior of the balance due to electrification are entirely obviated by placing on the floor of the balance a little uranium oxide. Before finally adjusting the beam was boiled in *aqua regia* and washed with distilled water. The central and only knife-edge of the more sensitive balance was ground upon a quartz rod and rests on a polished plate of quartz crystal. Attached to one end of the beam is a small quartz bulb containing air sealed up at a known temperature and pressure. At the other end could be attached a quartz counterpoise of any desired shape. The effective weight of the air contained in the quartz bulb will vary with the pressure of the air inside the case. The principle of the method of measurement consists in measuring the change in pressure of the air in the balance case required to maintain equilibrium when there is a change in weight of the counterpoise. Thus a change in pressure of 1 millimeter in the case was found to correspond to a variation in effective weight of 1 3 $\times 10^{8}$ grammes and an alteration of 1 deg C at 20 millimeter pressure to a variation of less than 1×10^{-9} grammes. The construction of the second type of balance is also described.

TRADE NOTES AND FORMULÆ.

Cement for Repairing Celluloid.—Dissolve 1 part of camphor in 40 parts of alcohol and add an equal quantity of shellac. The cement must be applied hot and the celluloid articles kept pressed together till it cools.

Disinfectant Paint (Horst).—5 to 10 parts of carbolic acid 15 parts of manganese 10 parts chloride of calcium 10 parts china clay, 20 parts fossil meal 10 parts of dextrine or gum arabic, and the requisite proportion of water.

Syderamine Cement.—To prepare syderamine cement for steam engines water conduits etc mix and knead equal parts of graphite iron filings and unslaked lime with about *20* per cent of linseed oil varnish or a varnish substitute.

To Paint on Cement with Oil Color.—The freshly applied cement is to be washed twice a day for a week with fresh water and after being allowed to dry thoroughly twice soaked with linseed oil. On cement thus treated any oil paint will hold.

Cement Composition for Painting Wood.—A good coating for protecting wood against the weather may be made of 1 part of cement *2* of sand 1 of pressed-out casein and ¾ of buttermilk. Stir frequently during use and make only as much as can be used during the next half hour. Apply as evenly as possible and not too thick by means of a brush to the wood which must be somewhat rough and repeat the coating.

Harmless Coloring Material for Sugar.—Red. One part each of cochineal burnt alum and purified potash and 2 parts of tartar powder fine and mix. Triturate with water to the quantity and concentration required leave to stand for a few hours with occasional stirring and filter. Blue. Take indigo carmine in paste form and enough water to obtain the desired shade of color. Yellow. One part of saffron and 10 of dilute alcohol (7 + 3). After squeezing off the liquid treat the saffron again with 55 parts of dilute alcohol and mix the two extracts. For cheaper sugar articles use tincture of turmeric in the proportion of 1 to [illegible]. Green is obtained by mixing yellow and blue, orange by mixing yellow and red. Aniline colors free from arsenic may also be employed.—Chemisch Technische Spezialitäten.

Washing Putty for Varnished Work.—Grind umber or fawn brown in a mill or on a grindstone with oil varnish and a sufficient quantity of siccative to a thick paint and work up thoroughly with dry unburned pine soot to the consistence of a soft cement. With this putty which can be easily and conveniently handled first fill up all holes and joints also apply a thin layer with a putty knife here and there to single strips and portions on wheels and wagon frames or on porous wood. The washing now following must be performed before the filler or surfacer becomes dry. Take a small vessel with water in which a few drops of turpentine oil have been poured dip the finger in it and wash the treated portions till the surface has a uniformly thick coating. When dry polish with fine sandpaper and paint with the desired color.

Water-Glass Size.—Dissolve solid potash or soda water-glass in a copper boiler (or a clean iron boiler) by means of boiling water and to the solution obtained add as much sodium hypochlorite (Javelle water) as may be necessary to destroy the brown color and render the fluid colorless. While the lye is being added it must be quickly stirred. Then pour carefully and slowly into the water-glass sufficient sulphuric acid diluted with 8 parts of water to neutralize all the free alkali contained in it stirring vigorously till flakes of silicic acid begin to be precipitated and to float in the mixture the addition of the acid is not necessary where there is only a very small quantity of free alkali. Pour the solution of potash or soda water-glass thus obtained into clean boilers of copper or iron and concentrate it by rapid boiling to the required strength for which however there is no definite limit. When cold keep the mixture in glass bottles till required for use. When necessary, it may be diluted with distilled water for sizing yarn and a quantity of tallow or soap may be added at the same time as in sizing with paste.

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INSTRUMENTS AND METHODS OF THE OCEAN MAGNETIC WORK OF THE CARNEGIE INSTITUTION OF WASHINGTON

By L. A. BAUER, Director of the Department of Research in Terrestrial Magnetism

THE GENERAL PRINCIPLES FOLLOWED

FROM the very start of our ocean magnetic working on the chartered brigantine "Galilee" in 1905 two principles have been steadfastly held in view:

a. To get useful work done and make the results promptly known.

b. To strive toward the highest accuracy attainable in all elements consistent with *a*.

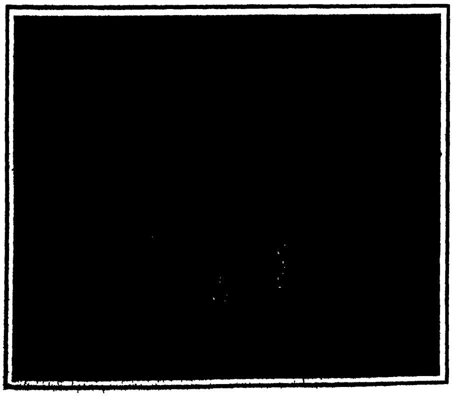
Early in 1905 I spent a month abroad consulting various eminent investigators as to their requirements of ocean work, but could get practically no additional information to that which I had already obtained in my previous experience on Coast and Geodetic Survey vessels, magnetic work on board of which was begun under my direction in 1903.

It was concluded that the best procedure would be to make a beginning in the Pacific Ocean at once by selecting a suitable vessel to be chartered for a term of years. As the result of some advertising, the "Galilee" was finally chosen, and as much as possible of the iron on board removed or replaced by non-magnetic materials. Next a special observing bridge* was constructed on which the instruments were mounted. The result was that we had a vessel for which at the places where the various magnetic instruments w[illegible] [illegible] were the smallest of [illegible] [illegible] of those specially constructed for Antarctic exploration, the "Discovery" and the "Gauss."

We next strove toward a symmetrical development of all the instruments. It was recognized as a mistake to take up [illegible] any one instrument and devote exclusive attention to it and disregard how it would fit in with the other appliances. Hence equal attention was bestowed from the start to all three elements, magnetic declination, dip, and the intensity of the magnetic force. Every known method and instrument [illegible] being still [illegible] thoroughly [illegible] [illegible] trials. [illegible] of [illegible] previous experience it was possible during the [illegible] trial trip from San Francisco to San Diego in August 1905 to settle [illegible] practically

* [illegible]

THE L. C. DIP CIRCLE MOUNTED ON GIMBAL STAND AS USED ON BOARD THE "GALILEE" AND THE "CARNEGIE," SHOWING THE MODIFICATIONS MADE BY THE CARNEGIE INSTITUTION



MEMBERS OF DEPARTMENT OF TERRESTRIAL MAGNETISM AT THE DEDICATION OF THE ADMINISTRATION BUILDING OF THE CARNEGIE INSTITUTION OF WASHINGTON

THE STAFF AND CREW OF THE "CARNEGIE" AND THE AFTER OBSERVATORY

View showing instrument mounted inside for obtaining the horizontal magnetic force and the magnetic declination. A similar observatory is forward of the bridge. These domes have removable parts which can be turned to any part of the skies so that both astronomical and magnetic observations can be made under shelter.

A MAGNETIC CHART OF THE WORLD

A MAGNETIC CHART OF THE WORLD

throughout the three years 1905-08 the Galilee was in commission

It was quickly shown that by the methods employed whereby each element was determined in two different ways with different instruments and by different observers the observational errors were not only considerably less than the chart errors but were also in general less than or about on the order of the error of the ship deviation corrections In other words the uncertainty of the deviation correction very soon became our chief concern And if this was true with the precautions taken on the Galilee having smaller deviation coefficient than any other vessel engaged in magnetic work viz swinging ship every third or fourth day then how much more must it be true on a vessel having larger deviation coefficients and less opportunity for swings as was the case with the recent Antarctic vessels?

We saw no need therefore for deferring the getting of useful results until ocean instruments had reached the same state of perfection as land instruments unless we were assured that funds would soon be available for the building of a wholly non-magnetic ship This assurance we did not have when the work was begun on the Galilee In fact it was necessary to win confidence in our ability to make good what had been promised And so we were determined to make the ocean work a success Instead of spending three years or more in elaborate office investigations and writing memoirs it was thought best to start right out and get some work done and above all make the results known promptly

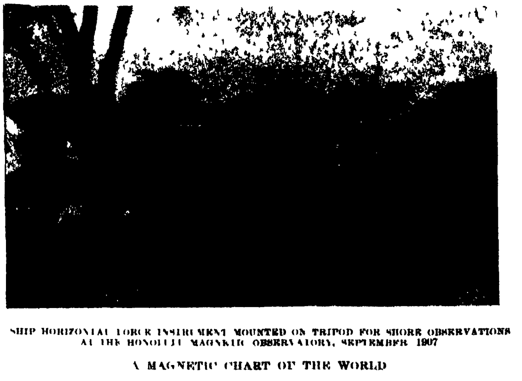
In June 1906 it was already possible to call attention to large systematic errors in the magnetic charts of the three elements for the Pacific Ocean Early in the spring of 1907 all the data obtained were supplied to the United States Hydrographic Office on the understanding that new magnetic charts of the three elements were to be issued however that organization has thus far only published the one of the lines of equal magnetic declination Some time in 1910 is to appear the volume of all the results obtained on board the Galilee Had it not been for the large amount of work entailed by the building and equipping of the new vessel the volume could have been issued in 1909

The prompt reduction of the observations and the many controls insisted on whenever the vessel reached port served to disclose the weak points but not always as quickly as desired Thus because the deviation coefficients were different at the various positions of the instruments it was not possible to get an immediate comparison for example in magnetic declinations made at two different stations on the ship The deviation corrections could not be successfully determined until the completion of a cruise covering a large enough range in magnetic latitude And here is where the great advantage of having a non-magnetic ship like the Carnegie counts most heavily It is now possible to make on board nearly a final computation a few minutes after completion of the observations and thus check up at once and repeat if necessary

THE INSTRUMENTS

The available space on board ship for magnetic work is necessarily restricted and in fact is never as large as one would like—not even on the Carnegie Hence it becomes essential to arrange the instruments so that what is aimed for can be accomplished without bringing them so close as to have an effect on one another and thus introduce once more deviation corrections There are three magnetic elements to be determined declination dip and intensity My general experience in magnetic work has forcibly impressed upon me the need of getting a totally independent check on each element of observation Hence each is to be determined twice simultaneously preferably and so there either must be 3 by 2 or six different instruments or each instrument must be arranged to measure more than one element The first suggestion is rarely practical because of the limited observing space and the desirability of taking advantage of the best possible conditions regarding steadiness of ship etc

THE "MARINE COLLIMATING COMPASS" OF THE CARNEGIE INSTITUTION OF WASHINGTON MOUNTED ON ITS BINNACLE



SHIP HORIZONTAL FORCE INSTRUMENT MOUNTED ON TRIPOD FOR SHORE OBSERVATIONS AT THE HONOLULU MAGNETIC OBSERVATORY, SEPTEMBER 1907

Our developments have accordingly been along the second line that each instrument should be capable of measuring at least two different magnetic elements

Thus an instrument primarily intended for magnetic declinations was arranged by a suitable deflection device to measure also the horizontal intensity one arranged chiefly for horizontal intensity was made so that declination could be observed with it and finally the L C dip circle permitted getting both the dip and the total intensity

THE SHIP DIP CIRCLE AND TOTAL FORCE INSTRUMENT

Beginning with the Lloyd-Creak or the so-called L C Dip Circle the chief improvements made on the original instrument as devised by Capt F W Creak and as supplied to the Antarctic expeditions of 1901-04 were as follows

Insistence on perfection in construction of the various parts of the instruments by the maker A W Dover of Charlton Kent notably of the pivots and jewels We finally succeeded, due to Dover's skill, in getting instruments for which the accuracy was not so very far behind that with land dip circles

Next it was found that the original deflection distance was a trifle short and in consequence, deflections were impossible when the earth's magnetic force fell below a certain value Thus on the 1905 cruise the instrument became unavailable for magnetic intensity observations before the vessel reached Honolulu A similar experience was encountered by the Coast and Geodetic Survey steamer Bache' on a trip to Jamaica and Colon Accordingly the distance was sufficiently increased and at the same time a second deflection distance introduced, making the instrument now everywhere available—something which the horizontal intensity instrument is not The latter is not suitable, for example in regions of high magnetic latitudes, where in consequence the force acting on a compass needle would be weak A brass holder for the deflecting needle was made so as to avoid handling the needle during a set of observations the passage from short distance to long distance being accomplished by a simple inversion of the holder the needle being mounted eccentrically inside

Next the milled heads of the footscrews were graduated and means provided for insuring that the instrument when mounted on the gimbal stand was actually level The heights of the footscrews were repeatedly determined and controlled for an invariable and level position of the circle whenever the sea was calm or when the vessel was in port and thus the instrument set level in between I do not remember seeing described in any book on ocean magnetic work how the dip circle was actually set level on the gimbal stand although the full error of level may go into the dip (An accidental missetting of the footscrews upon one occasion by less than one complete turn produced an error of about one degree and a half in the dip)

The method of observation invariably followed yields four determinations of dip two of these being with the regular dip needles according to the absolute method inclusive of reversal of polarity of needle and two being deflected dips i e those resulting from the deflection observations at two distances for getting total intensity hence not involving any additional time The scheme of observation is such that each dip applies practically to the same moment of time and to the same position of ship which of course is moving throughout the observations At first the agreement between the directly observed dips and the deflected ones was not always satisfactory, but it was soon discovered that this was due to mechanical imperfections which have since been remedied Next two determinations of total intensity using two deflection distances are obtained Should one wish the scheme can readily be extended to include different sets of needles etc

It may be remarked here also that for rapid shore work e g for the purpose of examining into pronounced local disturbances the L C dip circle has been converted into a universal instrument by the addition of the telescope seen in the figures thus making it into a theodolite and a compass (not shown) has been attached with which declinations may be determined within 2 min or 3 min or the dip circle quickly set with it in the magnetic meridian

In addition to perfecting the instrument in itself special experiments have been in progress with the view of disclosing the cause of outstanding errors and suitable testing appliances have been devised There is no great difficulty in perfecting a magnetic instrument which shall admit of observations with the desired absolute accuracy over a limited region, but when it comes to insuring the same accuracy over practically the entire globe then problems present themselves scarcely to be appreciated Even for land instruments the problem is not such a simple one, as has been repeatedly found Hence it is of the utmost importance to get independent checks in every possible manner Every opportunity has been embraced in port to get shore intercomparisons between all ship instruments and land outfits (our own as also those of local observatories) With these improvements and the precautions taken an accuracy sufficient for all purposes is being obtained by us with the improved instruments Some further improvements are in progress

SHIP HORIZONTAL FORCE INSTRUMENT

Early in 1905 on account of the failures met with the L C dip circle in getting total intensities in low magnetic latitudes, as above reported, I undertook the devising of a special deflecting apparatus for horizontal intensity observations used throughout the "Galilee" work which could readily be attached to the ordinary navigation compasses At that time the Bidlingmaier 'double compass" had not been perfected, and even if it had it would not have answered our requirements We desired the simplest possible contrivance both from an instrumental standpoint and that of computation

Accordingly there was developed a deflection arrangement based on the sine-deflection formula, which implies that the deflecting magnet is at right angles to the deflected one when the state of equilibrium has been reached Instead of mounting the deflecting magnet off on the side, as is done in land magnetometers and also in Neumayer's "deviations magnetometer," used on the German Antarctic ship, the "Gauss," we mounted it vertically above the center of suspension of the compass card.

The magnets used in deflecting the compass card, the angle of deflection being a measure of the magnetic force were especially selected ones which could be quickly attached in a rigid manner to the deflector framework for horizontal intensity work and again readily removed for magnetic declination observations In the Bidlingmaier or German instrument both the deflecting and deflected magnet systems are movable compass cards and the instrument for best success ought to be treated entirely as an instrument by itself In our device the same instrument used for navigation of vessel or for getting magnetic declination can be converted in an instant to a horizontal intensity instrument and the design of not multiplying instruments unduly may be carried out

The German instrument possesses apparently however one advantage over ours viz with it one is independent of the ship's head or constancy of direction of lubber line since the angle made by the axes of the two compasses is at once twice the deflection angle which measures the magnetic force In our device it is necessary to read the deflected positions of compass from some zero or index as the lubber line which moves as the ship turns To overcome this difficulty two methods have been followed leading practically to identical results

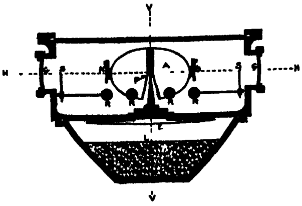
The helmsman is ordered to hold a given course to the best of his ability for about an hour during which numerous deflection readings are made in four positions of magnet and circle It is remarkable how at the end of a half to a whole hour the effect of yawing of a ship is eliminated the yawing being on the average as much to port as to starboard Hence while individual deflection sets may be quite erroneous the average yields a result comparing favorably with that derived from the dip and the total intensity observed with the L C dip circle

A method which has been more favorably employed is to take simultaneous readings of the ship's head with the steering or other spare compass close by and then apply the necessary corrections to the observed deflection angles Thus the agreement in the individual sets has been improved though the final result is practically the same as by the first method

Furthermore on the marine collimator compass aboard the Carnegie it has been arranged that the deflection angle can be read using as index some object outside the ship e g the sun or a star and thus the motion of ship entirely eliminated Instead of an actual celestial body it is hoped soon to substitute an artificial device Thus the difficulties due to a moving zero from which deflection angles are counted are entirely overcome without giving up the fixed principles started out with—simplicity and ready adaptability to a variety of purposes

Examining some of Bidlingmaier's observations closely it appears his magnet systems swing through large enough arcs especially when the sea is not smooth to compel him to go through the same laborious method of multiplying observations for a desired degree of accuracy as we are obliged in order to eliminate the motion of the lubber line

In the instrument on board the Carnegie (see figure above) the deflecting magnet is mounted below the card instead of above as was originally the case The magnet may be easily placed at four invariable deflection distances The construction has been improved in other respects by my assistants Messrs Fleming and Widmer.

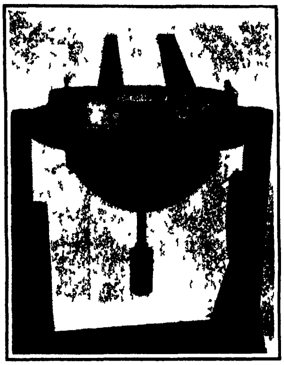


A SECTION THROUGH THE MARINE COLLIMATING COMPASS

View showing the four magnets R R R, R two of the four collimating lenses N N, attached to the buoyant ellipsoid A the scales S S each placed in the focus of the lens N to which it belongs at 1 O O are two of the four windows through which the scales are read These windows are segments of a spherical shell whose center is at the point of support of the optical system, hence the rocking of the bowl or the rotation produced by yawing of the vessel does not alter the optical conditions

INSTRUMENT FOR MAGNETIC DECLINATIONS

While my attention was being devoted to perfection of appliances and methods for dip and intensity, my assistant, Mr W J Peters, was making a special study of instruments for getting the magnetic declination at sea Every known appliance was put to a practical test—they all were found subject more or less to the error arising from the inevitable motion of the compass card while the magnetic bearing of the celestial body was being taken To eliminate this error it was necessary to extend the observations over a sufficiently long interval so that on the average it could be assumed that the various motions of the card had been eliminated This had to be done more or less blindly however as one could never tell just at what point of the arc of motion the magnetic azimuth of the stellar body was obtained Furthermore the various instruments all had movable parts subject to wear with frequent use such as the axes of mirrors or of prisms and of the azimuth circle on the bowl Likewise graduation errors on the card had to be considered Owing to these defects there were introduced apparent deviation corrections not due to the ship's magnetism but to purely instrumental causes To be able to separate the apparent from the true deviations it was necessary on the Galilee work to go through an elaborate series of shore observations whenever the vessel reached port The ship instruments were invariably dismounted and used ashore alongside of the customary magnetic outfits for land work



VIEW OF NEW DEFLECTOR FOR HORIZONTAL FORCE OBSERVATIONS BEFORE BEING MOUNTED IN ITS BINNACLE ON THE CARNEGIE

As a result of the investigations the marine collimating compass here described was devised by Messrs Peters and Fleming and constructed with great skill and conscientious care by Mr Adolf Widmer chief instrument maker of the Department of Terrestrial Magnetism Such an instrument is now in successful operation on the Carnegie No such attention as far as known has been given by anyone else toward the perfection of compass work ,

The basis of the instrument is a Ritchie United States navy standard 8 inch liquid compass with the card, however removed and an optical collimating system with scale introduced enabling the observer to note the arc of motion of the magnet system while sighting on the sun or a star hence knowing precisely to what part of the arc the stellar azimuth applies In brief practically the same method of observations can now be used at sea as on land where the magnetometer circle would be set to some convenient point on the magnet scale and then scale readings taken of the positions of the magnet during the interval of observations The angle is next determined between the circle setting and some mark or the true meridian and the magnetic declination is finally deduced Similarly with the marine collimator compass the angle (say middle of scale) between the magnet and some celestial body as the sun is read with a pocket sextant to the nearest minute of arc at a given time and then readings of the magnet scale and the watch are taken With the aid of the time readings the motion of the sun during the interval of observation is taken into account and the true azimuths determined whereas the scale readings give the varying positions of the magnet system

With this instrument* therefore one is almost entirely independent of the yawing and rolling of the ship making it possible still to get satisfactory results when with all other azimuth circle devices hitherto used at sea observations would be wholly impossible or at least very uncertain

In ten minutes a value of the magnetic declination may now be obtained possessing an accuracy attainable with previous instruments only by most careful observation and by laborious repetitions extending over a half hour or more to eliminate the motion of the card Thus not only has the accuracy of declination at sea been increased but what is equally important the time has been reduced and the possibility of getting useful results in all kinds of seas greatly extended

It may also be pointed out that the effect of drag of magnet system moving in the liquid during changes of the ship's head is overcome in the present instrument as well as in the deflector above described for the method of observation involves turning the compass bowl opposite to the ship's motion

The chief outstanding difficulty at present is to get determinations of the magnetic declination when no celestial body is visible In other words a device is desired which will furnish at sea an azimuth mark whose direction will be invariable within the desired degree of accuracy during the intervals when celestial bodies are obscured This device for best success must be as simple as possible and not be a source of disturbance to the magnetic instruments The Anschutz Kaempfe gyroscope compass does not at present appear to fulfill these requirements

Fortunately when over the deeps as it is not necessary to observe the magnetic elements as often as on land i e the distance from point to point of observation may be if necessary 00 to 300 miles As a matter of fact every opportunity is embraced on the Carnegie to get a daily observation so that on the average the points are about 100 to 1 0 miles apart If because of cloudy weather declinations are missed for one or two days it is not as serious as it would be on land but still the opportunities of multiplying declination data by some device are exceedingly desirable

MISCELLANEOUS CONSIDERATIONS

Practical schemes for ocean observations to secure a desired result had to be devised and a number of printed forms prepared so as to simplify both the recording and the reducing of observations But few hints could be gleaned from the reports of previous expeditions as to the best methods for determining the deviations due to the ship itself for all three elements It remains to be seen whether any other expedition has gone into these matters as fully as was done for the Galilee Fortunately this troublesome part of the ship work has been eliminated on the Carnegie

It has been my observation that there is nothing so

Kelvin compass Horizontal force instrument Ritchie compass Dip circle and total force instrument.

Scientific Personnel

J P Ault Magnetic Observer H E Martyn Surgeon and Recorder J C Peters Commander

OBSERVING BRIDGE OF THE GALILEE AND INSTRUMENTS

A MAGNETIC CHART OF THE WORLD

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*For a more detailed description the reader may be referred to the Journal of Terrestrial Magnetism and Atmospheric Electricity for March, 1909 vol xiv p 17 harmful to magnetic research is lack of promptness in the reduction of the observational data and publication of the results To accomplish prompt reduction it is necessary to begin right viz to have instruments methods of observation and those of computation all form one harmonious whole and not be treated as though they were independent of one another

In a project such as the magnetic survey of the earth one could readily lose himself and spin out the survey so interminably that it would take nearer fifty years than ten or fifteen years the time allotted to complete it with no added advantage whatever On the contrary the application of proper secular variation corrections for a survey extending over fifty years would be a serious matter

An observer ought never to forget that his observations have no value until they have been computed and hence he must bear the computer in mind and consider what his task will be It is astonishing how such a simple truth as this is at times disregarded Having all these experiences in mind the work of the Galilee was arranged accordingly and still further has it been possible to put into actual practice these ideas on the Carnegie

Two days after the completion of the observational work at Falmouth England a summary of the magnetic results obtained on the Carnegie from Long Island Sound to Falmouth (September 1st—October 18th) embracing the three elements were sent to the chief hydrographic offices issuing magnetic charts and important errors were pointed out The summary was published in Nature ten days after the date of the last observation and Gen Rykatcheff presented the information before the Russian Geographic Society on October [illegible]th Some time in March of this year the complete results of the entire first cruise of the Carnegie are to be published After leaving Falmouth England the vessel proceeded to Madeira thence to Bermuda and returned to Brooklyn early in February

By the methods adopted it is possible for the director in his office in Washington to be almost as close in touch with the work as though he were continuously on the vessel himself In brief it may be said that the Carnegie is the most effective instrument of research in terrestrial magnetism thus far devised for mapping the earth s magnetic forces With the present possible rate of progress on land as well as at sea we may confidently expect the completion of a general magnetic survey of the greater part of the earth by 1915

One of the first lessons necessary to learn in ocean work is that it is rarely if ever possible to have ideal conditions In consequence the development of good judgment of the observer is one of the prime requisites Sometimes in an instant he must be able to change his plan of observation and be content with a fair degree of accuracy or get no observations at all

Geographical Positions —Equal care is bestowed upon the determination of the geographic positions of the points where the magnetic observations are made The astronomical observations and computations are made in duplicate and at times in triplicate by the observers and thus the positions are effectively checked Six well tested chronometers are carried aboard With the methods followed, it would appear that the errors in the final positions assigned will in general be less than three minutes of arc in latitude and in longitude

TESTS OF INSTRUMENTS AND OF VESSEL

Both with the view of testing the various appliances on the Carnegie as well as to ascertain whether we had succeeded in getting non magnetic conditions at the three places (A B and C) where the instruments are mounted special observations were made at Gardiners Bay Long Island August 31st to September 2nd 1909 just before setting out on our first cruise The results are given in the following table

Summary of Swing Observations at Gardiners Bay Long Island New York August 31st to September 2nd 1909

Ship s Head	West Declination		Dip	Horizontal Intensity in C G S Units	
	M C	Deflector	North	L C D C	Deflector
	Position A	Position C	Position B	Position B	Position C
	Degs	Degs	Degs		
N	11 41	11 11	72 09	0 1823	0 1830
NE	11 39	11 52	72 12	0 1823	0 1834
E	11 47	11 48	72 11	0 1820	0 1830
SE	11 39	11 29	72 11	0 1826	0 1834
S	11 34	11 41	72 09	0 1827	0 1831
SW	11 38	11 38	72 04	0 1824	0 1827
W	11 32	11 40	72 08	0 1822	0 1828
NW	11 46	11 32	72 18	0 1828	0 1832
Mean	11 39	11 40	72 09	0 1824	0 1830

The vessel was swung with both helms on three successive days and magnetic observations were made on each heading of vessel Looking over the results we notice not only a good accord among the instruments themselves but also find the values of the various magnetic elements the same on each heading of ship within the errors of observation showing the absence of deviation corrections of whatever kind Only one who has had experience both in the observations and reductions of magnetic elements determined at sea can appreciate the full significance of these results and can realize the advance made

Similarly the special observations made in Falmouth Bay after our trip across the Atlantic again showed the absence of corrections due to any possible ship s magnetism It is chiefly due to this happy circumstance that the present ocean work is being not only expeditiously accomplished but also with the requisite accuracy

Since the rapidity of the present work naturally will raise the question in the minds of some as to its thoroughness I may say the work is open to the inspection of anyone at any time A special point is being made to extend invitations to prominent scientific men to visit the 'Carnegie when in port not only for the purpose of becoming acquainted with the instruments and the methods but above all to give us the benefit of any criticisms or suggestions they may make I am privileged to quote from letters addressed to the President of the Institution Dr R S Woodward by two of our most eminent visitors at Falmouth

So far as I know the Carnegie is the first ship that has been especially built and designed for magnetic sea work and I was very much struck not only with the care which has been exercised to avoid errors due to the presence of iron but with the ingenuity with which the instruments have been arranged or modified in view of the special purpose for which they were intended In particular I was pleased with the skill with which two instruments placed in different parts of the ship could be used to measure the same element thus affording a valuable check on the accuracy of observations Sir Arthur Rucker F R S Newbury England November 6th 1909

Last week I visited Falmouth in order to have a look at the Carnegie and I should like you to know how very much pleased I am with all the arrangements on board There cannot be the slightest doubt that the results which the Carnegie will obtain will be of the highest importance not only in clearing up difficult problems of terrestrial magnetism but also for practical purposes of navigation —Prof Arthur Schuster F R S Manchester November 9th 1909

SOME OF THE RESULTS

Already important errors in the magnetic charts at present in use have been found by the Carnegie These errors owing to their systematic run for very long distances are of sufficient moment to be taken into account in practical navigation Thus it was found that the effect of the errors on the transatlantic tracks from New York to England is always to set the course of a vessel to the northward whether she is coming from the east or the west Off Cape Race Newfoundland a vessel may find herself too far to the northward of her track from 10 to 20 miles dependent upon circumstances and upon how long she may have failed because of possible cloudy conditions to control her position by astronomical observations

The observations made on board the Carnegie are accepted as correct by the leading establishments issuing magnetic charts

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POSITIVE COLORS

The following process suggested by Prof Namias permits of the preparation of lantern slides in almost any color and obviously it is also applicable to the production of the three constituent positives in the three color process The transparencies may be made on any plates but they should not be too dense After a careful washing subsequent to fixing they should be immersed in a mixture of equal parts of (a) Potassium ferricyanide 1 ounce distilled water 9 ounces (b) lead acetate ½ ounce glacial acetic acid 48 minims distilled water 9 ounces

The plate should be left in this mixture till the image is quite bleached that is for not less than ten minutes then washed thoroughly till the gelatine shows not the slightest tinge of yellow It should then be immersed in a [illegible] per cent solution of sulphuric acid which converts the image of lead ferrocyanide into lead sulphate This may be omitted but better results are obtained thereby

After another rinsing the transparency is immersed in the following Dye [illegible] grains sodium acetate 85 grains distilled water 20 ounces

The number of dyes that can be used is very great but they must be basic and not acid dyes The following are a few that give good results For three color work for red fuchsine for yellow auramine, for blue methylene blue For ordinary purposes Red rhodamine B xylene red orange acridine orange yellow auramine green methylene green emerald green brilliant green blue methylene blue Victoria blue violet methyl or crystal violet The images on bromide and gaslight papers may be converted into dye images in the same way but there is considerable danger of the paper being stained It is advisable to immerse the prints after the lead bath in a 1 per cent solution of nitric acid for about ten minutes and then wash and immerse in a very dilute dye-bath the weaker the better as it then will not stain the paper and although the print may have to be left in for twenty four hours the image will absorb the whole of the dye When the image is dyed deep enough wash in repeated changes of water till the gelatine is no longer stained

The image now contains silver ferrocyanide and it is as well though not essential to remove this which can be effected by the following bath Hypo 2 ounces water 16 ounces dissolve and add sodium acetate 1 ounce glacial acetic acid 48 minims water 4 ounces Two or three minutes is sufficient to thoroughly remove the silver The pictures may then be washed and dried or to make them more permanent they can be immersed in alum 1 ounce water 20 ounces copper sulphate 44 grains for two or three minutes and again rinsed and dried The colors obtained are very brilliant and very permanent —The Photographic Monthly

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WEIGHING THE EARTH

WEIGHING the Earth was the subject of a paper read by Prof Poynting to the members of the Midland Institute Scientific Society at Birmingham At the outset the professor remarked that in a strict sense the earth had no weight at all because the weight was really the pull of the earth itself on any other body And as the earth was pulling on all parts of itself equally in all directions the net result was of course no pull at all Yet they could imagine an experiment by which the earth might be weighed If they had a large pair of scales fixed at some point of the earth s surface and if they could only imagine to bring up the earth bit by bit, cubic foot by cubic foot weigh it and then return it to its place—if they could only get hold of the whole earth in this way they could really weigh it The experiments he was about to describe gave some idea of what the result would be It would work out at 13 000 000 000 000 000 000 000 000 pounds—or the figures 13 with 24 noughts after them

That was a clumsy result and could be expressed in another way The weight of a cubic foot of water was about 62½ pounds and the average weight of a cubic foot of earth was about 350 pounds, or about 5½ times as much as the cubic foot of water They could express the result by saying the density of the earth was 5½, meaning it was 5½ times the weight of an equal volume of water But this was quite imaginary, for specimens of the earth could only be obtained by mere scratches upon its surface They must look for some other method They could show by means of the pendulum that the earth pull varied at different points on its surface By timing the same pendulum at different parts of the surface they could find how the weight varied from point to point Peary was about one third of a pound heavier at the North Pole than when he started on his great journey

But there was something in a given piece of matter It remained the same wherever it was taken and that which remained the same was its mass What was meant by the mass remaining the same was that the same effort would produce in it the same motion wherever that effort was made Therefore what they were really seeking when they talked of weighing the earth was its mass The possibility of finding it was due to Newton for he taught that bodies pulled each other with forces depending solely upon their mass and their distance apart He showed the way and ten years after his death the first real weighing experiment was made Prof Poynting described this and later experiments carried out by Maskelyne and Hutton on Schiehallion in Perthshire which resulted in the density of the earth being determined at 4½ Then came the investigations by Mitchell and Cavendish, and finally those of Prof Boys who found the earth had 5 527 times the density of water Describing in detail the experiments he had made, Prof Poynting said they had their birth in Manchester, passed their early youth at Cambridge and came to their full age in Birmingham The final result he obtained was 5 493

According to the Engineering Record iron-slag block pavement has been used to some extent in the Borough of Richmond New York and has proved very satisfactory The chief assistant engineer considers it one of the least noisy of the hard pavements, and capable of withstanding a great deal of wear As an experiment, a row of slag headers was placed along the inside edge of car rails running through streets paved with asphalt blocks, where it is reported to have proved very effective in resisting the grinding wear of wagon wheels.

THE ARTIFICIAL SILK INDUSTRY.—II.*

CONVERTING WOOD INTO SILKEN FABRIC.

BY W. P. DREAPER, F.I.C.

Continued from Supplement No 1784, Page 167

PROCESSES OF MANUFACTURE

Chardonnet Process—The original plant at Besançon started with an output of 50 kilos a day in 1891 it had reached 1 500 kilos in 1904 and 1800 to 2 000 kilos in 1907 and seems to remain at that figure in 1909 The breaking strain is given at 1 5 grm per denier and the elasticity at about 15 per cent Whether elasticity is quite the term to use in the case of artificial silk is perhaps open to question It is doubtful if the stretching before breaking which takes place can be compared with the actual elasticity of the real fiber

Great precautions are necessary in the production of the solution of guncotton The polariscope is used in determining the correct state of solution The jets through which the collodion is squirted are accurately regulated by micrometric measurement The process of denitration is of course a reducing one and the details remain a secret Temperature of the bath is a consideration and the great aim is to reduce the loss of strength to a minimum Years of study have greatly improved this operation and have produced a thread which varies very little in this respect from day to day

The statement is made that in 1907 2 500 000 liters of alcohol were consumed in the Besançon works so that each kilo required between 4 and 5 liters of alcohol in its manufacture A kilo of 199 denier thread of this silk contains 90 000 meters in length or nearly 3 million meters of single filament as squirted from the jets The selling price of this product has been given as 30 fr per kilo in 1896 26 50 fr in 1897 and 21 75 fr in 1898 In 1903 it reached the price of 40 fr per kilo and it may be taken at 20 fr to-day

Zinc chloride process—The first patented invention dealing with the production of artificial filaments by the direct solution of cellulose in aqueous solution and without the intervention of the nitrating process was made by Wynne and Powell in 1884 (Eng Pat 16 805 of 1884) These investigators seem to have confined their attention to the industrial production of electric light filaments and this process has proved itself of great value in this direction and is in use to-day

In conjunction with H K Tompkins I took out further patents in 1897 dealing with details In one of these patents the advantage obtained by drying of the fibers or threads in a considerably stretched condition' was emphasized This practice has since found a place in all the artificial silk processes dealing with the direct solution of cellulose which have since reached the industrial stage and without it it is impossible to obtain yarns of the maximum brilliancy

Bronnert in 1899 patented the preliminary mercerizing of the cellulose and claimed that the solution was correspondingly facilitated A good deal of work was done in this country by the Cellulose Silk Syndicate Ltd in connection with this process and also by Bronnert on the Continent but in spite of statements to the contrary I do not think that this process has ever been worked on a very large scale

The cupro-ammonium method—As before mentioned this originated with the Despeissis patent (Fr Pat 203,741, Feb 12th 1890) Nothing was however done with the process until Pauly re-patented the process in 1897 (Eng Pat 28 631 of 1897) The cellulose is dissolved in an ammoniacal solution of a copper salt The details of this method are of course not made public but after filtering a satisfactory solution may be obtained The coagulating solution may be a 15 per cent solution of sulphuric acid copper sulphate and ammonium sulphate being produced and the cellulose is precipitated in the thread form and wound on suitable winders which are usually made of glass The newly formed fiber is then washed on these holders with fresh water

E Bronnert (Eng Pat 18 884 of 1899) claims the treatment of cellulose with caustic soda and then copper sulphate is added When ammonia is added to the resulting mixture of cupric hydrate cellulose and sodium sulphate a solution of the cellulose is obtained Many patents have since been taken out, and it is obviously impossible to disclose the exact procedure in any works even if they are known

The recovery of the solvent materials is mentioned later Fremery, and Urban have observed (Eng Pat 20,[illegible] of 1899), that it is advisable to dry the product in two stages First at 104 deg F and afterward at a higher temperature If the yarn be submerged in water at a temperature of 158 deg to 212 deg F they claim that a dehydrating action takes place with beneficial results

Viscose Process—In the year 1892 Cross Bevan and Beadle (Eng Pat 8 700 of 1892) patented their method of bringing cellulose into solution for industrial purposes but it was not until 1903 that Stearn (Eng Pat 1 020 of 1898) disclosed a commercial method of preparing filaments by precipitating this solution in the required manner by means of a solution of ammonium salts This process was found to offer special difficulties but to-day they have been overcome and as a result of the initial work and first experiments at Kew works have been erected at Coventry by Messrs Samuel Courtauld & Co Ltd where this product is being produced in increasing quantity The process is also being worked at Sydowsaue near Stettin in Germany (Kunstseide und Acetatwerke Fürst Henckell Donnersmarck) in France at Arc la Bataille near Dieppe (Société Française de la Viscose) and in Italy

Further important work has been done in this country on this process by Courtauld and Wilson (Eng Pat No 21 405 of 1907) who suggested the addition of glucose to the precipitating bath and Topham (Eng Pat 23 158 of 1900) who applied the turbine method of collecting the threads to these artificial fibers an extension I believe of its previous use in the spinning of very short fibered yarns such as asbestos Many patents have been taken out by other investigators which deal with the preparation of the solution methods of squirting and subsequent treatment of the yarn but they are too numerous to mention here It is interesting to note in passing that the jets used for squirting in this process are made of platinum

An extension has been granted to the original inventors for their patent right in this country so that although the patent dates from the year 1892 the rights are still in operation

Cellulose silk process—This product is manufactured under the Thiele patents at the English works at Great Yarmouth Yarn is being produced down to 45 denier or even lower The process is a modified copper ammonia one but there are many secret details connected with the manufacture In spite of the relative fineness of the yarn the number of filaments is greatly in excess of other makes which are on the market at the present time

Cellulose acetate process—Several patents have been taken out in this direction notably by the Bayer Company the Badische Company and the Donnersmarck Company They chiefly deal with the control of the methods of preparing the cellulose acetate The question of a suitable solvent seems to present a great difficulty although it is stated that there are many derived acetates and that some of these are soluble in alcohol or pyridine but chloroform seems to be the chief solvent Quite recently (Eng Pat [illegible] 654 of 1909) it has been claimed that formic acid is a satisfactory solvent If this is so a distinct advance has been made

Gelatin and Casein Processes—Very little has been done in this direction from the commercial point of view In 1897 Millar patented a gelatin process (Eng Pat 2 713 of 1897) In 1907 Mugnier used vegetable albumins with the addition of borax and Jannin patented the use of a solution of gelatin glycerin and formaldehyde in 1904 (Fr Pat 342 112) Casein was used by Chatelineau and Fleury Timpe and Todtenhaupt but little has been heard of these processes

Recovery of solvents The recovery of raw materials used as solvents is an important step in the nitro cellulose and copper ammonia processes It is so far as I know of small importance in the manufacture of viscose silk In the first case the recovery of alcohol ether or acetone from the air is important from the cost point of view but is a difficult operation Exactly what proportion is recovered has not been disclosed

Quite recently the Tubize Company have patented the absorption of the alcohol and ether vapor in sulphuric acid of 62 deg B at 20 deg C

In the copper ammonia process both the copper and the ammonia can be recovered by known means When the precipitating liquid is of an acid nature electrolytic methods are available for the removal of the copper, leaving the ammonia behind in solution This solution may be used for manuring purposes or the copper may be precipitated as sulphide

Recently applications of the known reducing action of glucose have been brought forward in the case where the precipitating solution is of an alkaline or caustic nature The addition of glucose to the precipitating bath throws the copper out of solution almost immediately and the precipitating solution has a much longer life This process works well in practice

These few remarks will indicate some of the methods adopted in different cases dealing with this important branch of the manufacture

Machinery Each process has its special requirements as regards the machinery employed and these have been naturally met in various ways Companies working the same process in different countries differ materially in actual methods In addition to this there is a mass of detail which in many cases is not protected in any other way than that of secret working and may be confined to the working of a single factory Under these conditions I can only indicate one or two cases which may illustrate the methods adopted in the manufacture of these threads

The first case is that of the original Chardonnet apparatus This is of interest as showing in the original patent (Eng Pat [illegible] of 188[illegible]) the amount of detail already available in those early days The thread passed from the jet which had a bore of 1 20 to 1 th mm through a very short column of water and then on to the winder When a thread broke the broken end was seized by pinions and carried over guides to the reel to be wound The pinions still ascending are cleaned by a rapidly revolving brush before they descend again to pick up any more broken ends This movement is repeated several times a minute Air heated to 8[illegible] to 90 deg F is passed by supply and discharge conduits through the outer chamber The vapors carried by the air might be condensed and removed by cooling and the air after warming returned to the apparatus The so-called Topham turbine system of collecting and spinning the threads at the same time (Eng Pat 23 158 of 1900) is a good illustration of the methods adopted to overcome the difficulties in manufacture The squirted thread passes over a roller and thence into a rapidly rotating box The fibers or thread as they are fed in are twisted together and are caused by the centrifugal force to form a compact coil around the interior of the box and to be formed into hanks or skeins If the boxes are deep a longitudinal reciprocating movement can be given to either the box or the funnel to make sure of the even coiling of the thread in the skein form I have seen this apparatus at work on the Continent and it certainly illustrates a very ingenious method of combining the skeining and twisting in one operation It is or has been largely used in the manufacture of artificial silk It reduces the strain on the newly formed threads to a minimum

A third example is that of one of the more recent patents dealing with modifications in the Thiele two-solution process of spinning (Dreaper Eng Pat 21 872 of 1908 see this J 1909 124C) In this case arrangements are made so that the freshly squirted thread comes in contact with a precipitating solution which acts comparatively slowly and then passes into a stronger one

(To be concluded)

The transmission lines of the Niagara Lockport and Ontario Power Company running from Niagara Falls Ontario to Syracuse New York have recently been provided throughout their entire length with a device designed by Mr L C Nicholson of the Buffalo office of the company which is said to afford excellent protection against lightning troubles A metal ring is supported on the frame of the tower just below the lower petticoat of the insulator in such manner that the distance between the line wire and the ring is shorter than the distance between the line wire and the insulator pin The ring which surrounds the insulator and is larger in diameter than the latter is thoroughly earthed to the tower so that the tendency would be for a lightning discharge to jump the shorter distance between the line and the ring in preference to the longer route to the pin and thence to the ground Moreover the arc if there be any in crossing the path thus formed is kept away from the insulator and trouble due to arcing is minimized The device is claimed to have met all expectations

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* Paper read before the Society of Chemical Industry and published [illegible]

WRIGHT VS. PAULHAN.

EXTRACTS FROM AFFIDAVITS AND JUDGE HAND'S DECISION IN THE CASE OF THE FARMAN AND BLÉRIOT AEROPLANES.

On February 17th, Judge Hand of the United States Circuit Court, Southern District of New York, rendered his decision in the case of Wright Brothers vs Louis Paulhan, and granted a preliminary injunction pending adjudication of the Wright patent M Paulhan was required to put up a $25 000 bond for one month in case he wished to continue making exhibition flights in the United States He ceased making such flights, returned to New York, and succeeded in getting the requirements changed to a weekly bond of $6,000 Meanwhile on February 26th, Mr. Curtiss succeeded in obtaining a re-hearing in the Wright case against him, in which a preliminary injunction was issued also

Below are given extracts from some of the affidavits put in by the defense (for which we are indebted to Aeronautics), and a part of Judge Hand's decision

When Paulhan arrived in this country, papers in the suit were served upon him The next day Judge Hazel's opinion in the Wright Curtiss suit was rendered and that afternoon the Wright Company got an order to show cause why Paulhan should not be enjoined from flying This motion was argued before Judge Hand on February 1st and 3rd

At one point in the hearing on the latter day, Wilbur Wright himself took up the argument and was so convincing that the Court announced his intention to immediately grant the injunction, but a question to Wright by Israel Ludlow, who is associated with Clarence J Shearn in Paulhan's defense, raised the point of reasonable doubt whether the Farman machine operates like the machine of the Wright patent

HOW WRIGHT'S MACHINE TURNS CORNERS

An affidavit of Lieut F E Humphreys of the Signal Corps, who has flown the government machine, was put in evidence by the Paulhan side The Wright attorneys also put in a Humphreys affidavit which amplified the statements made in the previous one

Lieut Humphreys operation of the Wright machine is described by him as follows as regards turning:

"In turning in flight the outer wing is elevated by increasing the angle on the side opposite to that to which it is desired to go Elevating the outer wing is essential to prevent the aeroplane from skidding The rudder is turned in the direction to which it is desired to go, which is also the side having the smaller angle of incidence Therefore, the wing with the greater angle rises and advances instead of being retarded as would be the case if the wings were warped without any movement of the tail Technically considered, there are differences between the action of the vertical rudder of the Wright machine and the rudder of a ship, since in correcting lateral balance by warping the wings the rudder may be turned to one side to correct difference of the right and left wings, without causing the machine to turn As the rudder is turned, the wings are warped Then the angle of inclination on the outer side is brought back slightly past the normal so as not to continue the transverse inclination of the aeroplane further Usually, during the turn the larger angle is on the same side as that to which the rudder is turned with reference to the longitudinal axis of the machine To restore the course of a straight line, the rudder is brought back to a neutral state, and the aeroplane rights upon a horizontal balance By the instruction of Mr Wright, I aim to keep the machine skidding slightly outward when circling so that the rudder may be receiving a pressure on the side opposite the wing with the greater angle even when turned slightly toward that wing as compared with the longitudinal axis of the machine, since the axis of the machine and the relative wind do not quite coincide This is the rule in all cases unless unforeseen and unusual occurrences interrupt the operation

"The warping of the wings and the turning of the rear rudder is moved by one lever which has two motions, that is a forward and backward motion from front to rear to turn the rear vertical rudders from left to right, and the right and left transverse motion to increase the angle in each section, right and left respectively, that is to say, if one wants to make the larger angle on the right the lever is moved to the left This enables the operator in turning a corner, to increase the angle of inclination on the outer wing section and to elevate the same, or, should it become necessary, as sometimes happens to be the case from disturbing wind currents, the operator may increase the angle of inclination of one side and at the same time swing the rear rudder in the direction of that side of the machine whose angle has been made smaller All the way around the curve the position of the rear vertical rudder and the warped surfaces vary; one state of affairs requires a different position of the levers from another In the last flight I made on the machine, which was in company with Lieutenant Lahm, the machine was flying close to the ground, when an attempt was made to raise the depressed wing by increasing the inclination of the low wing and decreasing the other, but owing to failure to promptly set over the tail toward the wing whose angle had been decreased, the depressed wing refused to rise and struck the ground, causing damage to the machine"

HOW PAULHAN TURNS

In an affidavit submitted by Paulhan he says that though the "rear rudder is sometimes moved toward the angle of least incidence at the beginning of a sharp turn," it would be "suicidal to connect the rear rudder with the warping of the wing so that the rear vertical rudder would always be turned to the side having the least angle of incidence or to have the rear vertical rudders in any degree controlled by the movement of the aileron or the warping of a wing" He goes on to say -

Under one condition an operator might increase the angle of incidence considerably on the right and move the rudder slightly to the left. Under different conditions he might increase the angle of incidence slightly on the right and move the rudder considerably toward the left Under other conditions he might increase the angle of incidence on the right and move his vertical rudder to the right For example, suppose the aeroplane to be proceeding northerly with the right wing tilted up at an angle of 10 degrees or more and to be suddenly struck with a gust or air current from the east The operator would instantly bring his rudder toward the east or the angle of greatest incidence so as to swing or steer the aeroplane into the head of the wind It is to steer with, maintain and control direction that the vertical gear rudders are used and it is only occasionally as in turning a sharp corner that the rudders are used by turning them to one side or the other at the same time that the angle of incidence is changed and even in those cases as above stated, whether the rudders are turned toward the angle of least incidence or the reverse depends upon the condition of the moment The all essential requirement for safe and practical operation is that the operation of the vertical rudders shall be wholly independent of and distinct from any wing warping or increasing angles of incidence by means of ailerons or otherwise

"In turning a corner in the Farman biplane machines or in any aeroplane that I am familiar with, it is not at all essential to use the aileron so as to increase the angle of incidence on the outer edge in turning a corner There are circumstances in making a turn in such machines and in a straight away flight when the operator would use the aileron or warp the wings without turning the rudder at all and very often the rear vertical rudders are used without any interference with the ailerons or without any wing warping

"If for some cause such aeroplanes move obliquely to their longitudinal axis, in other words, skid, the use of the rudder alone will correct the aeroplanes' equilibrium and bring them back to their normal line of advance The operator can make a complete turn by the use of the rear vertical rudders alone and without using either ailerons or warping to correct horizontal equilibrium The rear vertical rudders have a most powerful turning effect in all cases In making a sharp turn the outer end of the aeroplane may be tilted up and a new plane of movement established which may be at an angle of ten or more degrees The tendency of the rudder during such movement is to swing the tail to the outer side of the turning arc with great rapidity.

"Where one side of the Farman biplane . . . is depressed or tilted downward the side which is depressed tends to move more slowly and the aeroplane turns in the direction of the depressed side"

PAULHAN SAYS WRIGHT PATENT OF MACHINE IS IMPRACTICABLE.

Paulhan states in his affidavit that he is informed that the Wrights have abandoned the system described in their patent and now build aeroplanes with absolutely independent action and control of rudders and wings He says

"An aeroplane with flat sustaining surfaces is useless To get lifting power the surfaces must be curved and the curve is a matter of careful study and adjustment and is not any mere curve that may be produced by a sagging or bellying canvas As for having the rear vertical rudder controlled by and dependent upon the movement of the rope or lever that changes the angle of incidence, that is utterly impracticable and extremely dangerous. . Under such conditions a gust of wind or sudden air currents from the side of the aeroplane that was tilted up would inevitably upset the machine unless the rudder could be quickly and sharply turned toward the wind so as to steer the machine around into the face of the wind"

PRIOR ART.

That the Wrights admitted the prior art in the file wrapper of their application for patent is claimed in the quotation following

"We are aware that prior to our invention flying machines have been constructed having superposed wings in combination with horizontal and vertical rudders"

After mentioning the airship patent of Lewis A. Boswell, September 24th, 1901, the Mattullath patent application filed January 8, 1900, and the D'Esterno, Mouillard, Le Bris and Ader machines discussed in Mr Chanute's "Progress in Flying Machines," an affidavit is submitted signed by Dr A F. Zahm. In this he refers to his paper read before the Chicago Conference on Aerial Navigation in 1893, and printed in the proceedings in 1894 in which Dr Zahm suggests moving the slats of the Phillips machine on either side thereof so as to present one side of the machine at a greater or less angle of incidence than the other to "arrest all pitching, rocking, and wheeling" He goes on to say·

"In general, at the close of the nineteenth century all essential principles and contrivances of pioneer flight were well worked out except one—a suitable motor A light automobile motor appeared in the later nineties and promptly thereafter followed the dynamic flyer The essential elements of aviation, barring the motor, had been clearly worked out No further need to prove feasible the heavier than air machine, for that had been done repeatedly Scientific design and patient trial, not physical research, was the chief demand Further research would improve the aeroplane, but not bring it into practical operation The aeroplane was sufficiently invented. It now wanted, not fastidious novelty, but concrete and skillful design, careful construction, exercise in the open field

"The first person, to my knowledge, to apply for a patent involving the three rudder system control was Hugo Mattullath, who in 1899 showed me, and many others, plans for an aeroplane having a vertical rudder in the rear and lateral steering planes on either side, fore and aft, of the main body, so disposed that he could cause the aeroplane to turn about either of the three rectangular axes at will"

There is very little that I should wish to add to Judge Hazel's opinion in the case of the Wright Company vs Curtiss were it not for the ardor of the defendant's counsel and their insistence that a different showing has been made here In view of the seriousness of the contest, I feel obliged to give my own reasons for this decision.

The defendant says that he does not infringe the patent because he does not use a device which automatically always presents to the wind that side of the rudder nearer the angle of lesser incidence; and that if the patent be construed as merely a combination of a vertical rudder with a device for creating a differential in the angle of incidence of the rear marginal edges of the plane, it is not a novel discovery, but was anticipated in the art. Therefore, the first consideration must be the proper construction of the contested claims of the patent in suit.

Claim seven is the main reliance of the complainants and that is as follows: "7. In a flying-machine, the combination, with an aeroplane, and means for simultaneously moving the lateral portions thereof into different angular relations to the normal plane of the body of the aeroplane and to each other, so as to present to the atmosphere different angles of incidence, of a vertical rudder, and means whereby said rudder is caused to present to the wind that side thereof nearest the side of the aeroplane having the smaller angle of incidence and offering the least resistance to the atmosphere, substantially as described." The specifications and diagrams upon which this claim was allowed after a pendency of three years in the Patent Office, showed the tiller-ropes of the vertical rudder attached to the rope which ran along the rear of the lower plane, in such wise that when the marginal parts of the two planes were warped as indicated, the rudder was turned toward the margin which had the lesser angle of incidence. Moreover, there was a constant proportion between the degree of deflection of the rudder and that of warping of the plane. The Blériot and Farman planes, which the defendant uses, do not have the combination described and the complainants have in fact at times abandoned it. It is therefore a very sound contention that if the connection between the tiller-ropes and the warping device in a constant proportion, be an essential element in the combination patented, the planes which the defendant uses are in no sense infringements, and the case need not go into the question of the validity of the complainant's patent at all.

To an intelligent understanding of the invention and the question of how essential is the attachment of the tiller-ropes to the warping rope, the method of maintaining equilibrium under the patented combination must first be set forth. Assume an aeroplane with or without dihedral sustaining surfaces to be propelled through the air, having the combination specified, and also suppose the left wing has been accidentally depressed. That in itself will result, as all agree, in starting a revolution toward the left. This is the resultant of two motions, first, the forward motion of the plane, and second, the motion at right angles caused by the sliding of the machine laterally in its own plane and over the successive columns of air. The resultant is precisely analogous to any planetary motion. This resultant is accentuated by the movement of the center of pressure toward the depressed lateral margin, giving a greater leverage to the propeller nearer the elevated wing. Also, the vertical rudder becomes transverse in its reaction to the lateral motion of the aeroplane and consequently, the rudder is pushed up, and by its leverage further turns the direction of the plane to the left.

Thus the machine will begin to revolve to the left; moreover, this very motion will cause the right wing to be further elevated, because of the increased drift, or head resistance caused by its increased speed, and the decreased drift against the left wing, caused by its diminished speed. Thus in turn the initial depression creates a revolution, and that in turn an increased depression with its corresponding acceleration of revolution, so on co-operating till the machine will swoop downward to the left to its entire destruction.

The first part of the patented combination for correcting the depression of the left wing is to increase the angle of incidence upon the left side, so increasing that component of the drift which is opposite to the action of gravity. However, contrary to the assumptions of earlier speculators, this alone has a precisely contrary effect to what might be expected, because, although the lifting component of the drift is increased, the head resistance is much increased and this decreases the velocity of the left wing in greater proportion than the increase in the angle of incidence tends to raise it. That revolution, already initiated by the very tilt itself, is therefore increased by the differential in the angle of incidence between the two margins. The right wing, which has thus an added velocity relatively to the left wing, will, in spite of its lesser angle of incidence, rise more rapidly than the left wing. Unless the revolution be corrected the increased angle of incidence will, therefore, remain ineffectual to restore the balance, but will rather further disturb it, and it is therefore necessary that the rudder is a part. The statute authorizes such an in counteracting the revolution. When this is done, the increased angle of incidence on the left wing becomes effectual and the left wing rises, so restoring the equilibrium of the plane. It is the combination of a differential in the angle of incidence with a rudder which operates against the side of lesser angles which produces this result.

Now to come back to the connection of the tiller-ropes to the warping mechanism. This is, of course, one "means whereby said rudder is caused to present to the wind that side thereof nearest the side of the aeroplane having the smaller angle of incidence, and offering the least resistance to the atmosphere." Literally considered, tiller ropes under the independent control of the operator are equally such a means. But the invention is not of a machine; it is not an invention of this means of so turning the rudder, but it is an invention of a combination of which this action of the rudder is a part. The statute authorizes such an invention and if the combination be not a mere aggregation of old elements, as I shall try to show hereafter, then the precise means is of no consequence. In the patent in suit any skilled operator, who may serve *pro hoc vice* for a "skilled mechanic," finding the automatic connection unsatisfactory, would at once disconnect it and attach the tiller-rope to a lever or to a foot pedal which he could directly control.

As the Examiner said in his letter of July 14th, 1903, it is merely a matter of taste to attach the tiller-ropes to the warping rope. The machine would be changed, but the combination would remain, because there would remain the means of causing the rudder to operate on the side of lesser incidence. The defendant urges very vehemently that the means must be the means specified. All that the specifications need contain is so clear a description that any skilled mechanic may use the invention. Where the change is only an obvious modification of the means specified, and a modification which retains each element of the combination contributing the same effect as before, the claim is not too broad which includes the modification.

Of course, were the invention an advance over a prior art which had progressed already to the combination without any automatic movement of the rudder, then the claim must have been limited to the precise specifications. This would be because only when so limited would the patent be an invention at all and the construction would be necessary *utres valeat quam pereat*. The defendant insists that this is the case with the patent in suit and I shall consider that contention later. Assuming for the present, however, that the patent need not be so limited to be saved, then it becomes a pioneer, and as such under the well known rules is entitled to a broad construction.

Therefore, viewed first as a combination, not a machine, and second as a pioneer patent which advances by more than just the degree of an automatic connection, I cannot agree that it was not a fair equivalent to operate the tiller ropes independently by a mechanism under the direct control of the aviator. That connection was not essential to the three-rudder system of control.

The question next arises whether the fact, which I must assume from the affidavits, that the rudder under some circumstances of aviation is turned toward that side of the drift nearer the angle of greater incidence relieves the defendant of infringement.

In this connection the distinction must be carefully observed between turning the rudder toward that side of the main longitudinal axis which is nearer the angle of the lesser incidence, and presenting to the wind that side of it which is nearer that angle; the latter being the essential specified. While the two might readily be identified, a moment's consideration discloses that they will be quite different whenever the plane is itself turning in either direction. For example, if the plane is turning to the left in a circle radius is *r* and has itself a total length longitudinal axis, a, then the rudder, if free, would stress at an angle to the inside of the axis whose tangent is $\frac{a}{r}$, that is 1 $\frac{a}{r}$. That is to say the sharper the turn, and the farther the rudder is set aft of the plane, the more will the rudder in turning stream inward, and apparently the operator will be putting the rudder toward the angle of greater incidence although in fact, the rudder may be sustaining a wind pressure from the opposite side.

However, I should have no right upon this motion to interpret the defendant's affidavit as limited to the phenomenon I have described, and I shall therefore assume that the rudder under his operation at times presents to the wind that side nearer the greater angle of incidence. To determine whether this indicates that the defendant does not infringe, we should look at the purposes of the invention. These are stated to be (page 1, lines 16-24).

"The objects of our invention are to provide means for maintaining or restoring the equilibrium or lateral balance of the apparatus, to provide means for guiding the machine both vertically and horizontally, and to provide a structure combining lightness, strength convenience of construction and certain other advantages which will hereinafter appear." The question is not whether the defendant upon occasion may not find it proper or even essential to turn the rudder toward the greater incidence, but whether he uses the patent combination. For example, if the patent were for an automatic device, it would be no answer to say that the defendant used it only intermittently. This combination is in fact for a great part of the time used by the defendant "to maintain or restore equilibrium." If at times he avails himself of other methods that is nothing to the purpose and I may disregard it.

As a method of restoring equilibrium the defendant has not shown that the rudder can be turned toward the greater angle. All he has shown is that in making a sharp turn he puts his rudder to the opposite side. During such a turn he may doubtless for a short time abandon his equilibrium, restoring it when his direction has been changed, at which time if it remains disturbed, he must restore it by the use of the patented combination, in short, his evidence going no further than to show that he may execute certain maneuvers during which he can safely for a short period abandon the maintenance of his equilibrium. That in no sense affects the question that to maintain or restore it he must eventually resort to the method specified.

Much discussion has arisen as to whether the defendant's rudder is not in fact a "steering device." I concede that it is when free from the warping device at once an essential part of the combination and also a "steering device" and that the complainants in some of their machines at times use it strictly as such. It is also true that when connected to the warping ropes it could not successfully be used as a "steering device," as Toulmin says in his letter of July 11th, 1904. The question is whether the combination specified is not actually used, even though the tiller ropes are detached and the rudder thus made susceptible of being used to steer as well as to maintain the equilibrium of the plane. I think it is none the less the fact, when the ropes are detached, that the rudder when being used to maintain or restore the equilibrium must be used in the combination as specified and precisely as specified. It does not seem to me of consequence to say that by the detachment of the ropes it may acquire an added function and that too of a kind not patentable.

As an illustration of my idea, suppose that there were two rudders, one with the tiller ropes fixed to the warping mechanism and one free so as to be used simply for steering. In such a case no one could say that the addition of the second rudder would affect the combination. The infringement has simply dropped the automatically connected rudder and made the free one serve in both capacities. Is that not the adoption of an equivalent? The rudder yet remains a part of the combination with its means of being put over to the lesser angle. It has acquired by a simple suggestion to the mind of the operator an added use and a more varied power of adaptation in the combination. I should feel most unwilling in a patent of this character to construe it so narrowly as to exclude the modification from the purview of the patent.

Nor yet is it of consequence that there may be other ways of maintaining equilibrium as by using the rudder alone. Anyone is of course free to use such other methods.

I think there is nothing in the further objection that the Farman machine has two ailerons or flaps instead of a general helicoidal warp through the whole plane. The use of such ailerons is an obvious equivalent, and the only possible question arises from the fact that the ailerons cannot be given any negative angle. However the essential of the combination is a differential in the marginal angle and that is as well accomplished though the lesser angle can never be less than zero as though it could.

Considering therefore that the complainants carefully avoid limiting themselves "to the particular description of rudder set forth" I think that the detachment of the ropes from the warping devices, leaves the patent substantially the same as specified.

Having now determined that the defendant infringes, it becomes necessary to determine whether the showing upon the prior art is such as to throw any reason to doubt as to the validity of the patent. Moreover, in this consideration is involved the question of whether this is a pioneer patent because if the three-rudder system of control be an invention of the complainants, then they are clearly entitled to have their patent take place as a pioneer.

Before, however, considering the prior art, it is necessary to determine first whether the patent is of a true combination or of an aggregation and second whether it be merely a principle or abstract function, rather than a true invention.

As to the first, there can be no doubt whatever. The three elements are combined into an effect which is absolutely different from that which any one of them produces alone. The differential of angle instead of maintaining equilibrium would upset it. The rudder bearing upon one side only would not be sufficient. I am aware that the defendant contends that he can fly by steering alone, but I do not understand that he claims that in practice this can safely be continued permanently in machines of this type. In combination their result is not the aggregation of their separate results, it is the result of their mutual and antagonistic reactions. Even under the strict rule of Pickering vs. McCullough, 104 U. S., 318 here is fulfilled the requirements that the "old elements, all the constituents must so enter into it as that each qualifies every other, to draw an illustration from another branch of the law, they must be joint tenants of the domain of invention, seized each of every part, *per my et per tout*."

The question as to whether the combination is not merely of a function, is likewise plain. The combination is a definite adjustment of the material parts of a machine to secure a specified result. It is not the effort to patent a certain way of operating an aeroplane as the defendant insists, because the patent demands for its fulfillment certain physical parts in combination, able to work in the way prescribed.

The most plausible form of the defendant's argument is, I believe, as follows: "Given a plane with marginal flaps or a helicoidal warp and a movable rudder the rest is a mere way of operating the machine. The marginal warp is not patentable, nor is the vertical rudder, hence the patent must be upon the operation of the two in conjunction, and that is not a proper subject of patent under the statute." The answer is that if the combination of elements were not new, the patent would be merely upon the method of operation, but the combination is, as I have said quite new and the method of operating it need not be relied upon as the invention. No one before did in fact combine all these, and therefore no one gave to aviators the possibility of so operating.

(To be concluded.)

COUNTING PARTICLES SMALLER THAN ATOMS.

THE NUMBER OF PARTICLES PROJECTED BY CATHODES.

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

If a glass plate partially screened be exposed for some seconds to a cathode discharge, the exposed portion does not at first sight seem to be distinct in any way from the protected portion. By merely blowing slightly on the glass a very marked distinction is produced by the condensation of vapor on the portion acted upon. The same phenomenon is produced by means of the vapors of alcohol, aniline, etc., but is particularly striking and easy to observe in the case of mercury vapors (Figs. 1, 2 and 3).

FIG. 1.—GLASS PLATE, THE CENTER OF WHICH HAS BEEN EXPOSED DURING FIVE SECONDS TO CATHODE BOMBARDMENT.

Dr. L. Houllevigue, professor at the University of Marseilles, has been led by observations of this kind to examine more closely the condensation of vapors on cold surfaces. To this end he used in the case of water vapor a flat box 7 millimeters in thickness closed by two thin glass plates. Suitable ducts allowed either dried air or air saturated with water vapor (at a regulable temperature) to be introduced into this box. The precipitate of moisture in its interior could thus be made to increase or disappear at will merely by actuating two India-rubber bulbs. Fig. 3 is a microscopic view of the phenomenon obtained with a ninety-five-fold enlargement.

Even on an untreated glass plate the drops of moisture do not arrange themselves accidentally. If after a first deposit any trace of liquid be eliminated by a prolonged current of dry air or by heating the plate to 150 deg. C., the drops on subsequent condensation will be precipitated exactly at the same points.

As the condensation of liquid augments, the drops increase in size, although no new drops are produced. On the other hand, when some of the drops grow sufficiently to come into contact with one another, they merge and the number of drops will thus decrease. Again, if the plate has been rubbed or wiped in a given direction, the drops will arrange themselves in the same direction. If a scratch be made on the glass with a diamond, the drops will arrange themselves along this scratch and will crowd together in its vicinity. All these phenomena prove that under ordinary conditions the precipitate of moisture is connected with the presence of centers of condensation, dust particles, glass fragments, etc., on the plate. There is, however, no reason for supposing that these centers are electrified.

These experiments account for the phenomenon referred to in the beginning, viz., that a glass plate exposed to the impact of cathode particles is covered with a dense veil of moisture under the action of vapors. In fact, each projected cathode particle becomes a center of condensation and accordingly the [illegible] of a drop.

FIGS. 3-11.—MICROPHOTOGRAPHS SHOWING THAT DROPS OF MERCURY ARE NUMEROUS ON A SPOT BOMBARDED BY CATHODE RAYS.

Another means of showing the existence of such centers consists in dipping into a chemical silvering bath a glass plate, part of which has been submitted to projection from a silver cathode. The metal deposit produced in the bath is much thicker in the region struck by the cathode projection.

The question arises: As the discharge, in addition to the cathode matter itself, projects a stream of corpuscles, it is not evident at first sight which of the two projections gives rise to condensation by the production of centers of attraction. The following experiment shows that only the first kind of particles possess this property.

Into a tube projects a brass anode. A silver disk cathode is placed at right angles to the axis tube. Opposite the cathode are placed two mica screens, pierced each by a central hole 4 millimeters in diameter. The one hole can be covered at will from outside by a mica disk provided with an iron armature. Beyond the screen is placed, at 20 millimeters from the cathode, a crystal plate, the diameter of which is 24 millimeters.

After producing in the tube a vacuum of 0.001 millimeter, the one hole is closed and the discharge of an induction coil is thrown into the tube (the closing current being eliminated by means of a spark micrometer). A horseshoe magnet is placed near the tube so that the beam of cathode rays limited by the other hole is deflected sideways. The closed hole is then opened and the magnet is regulated so that the beam of cathode rays produces on the edge of the crystal disk a bluish fluorescence. After five minutes' discharge the operation is discontinued and the apparatus is dismounted. The silver projection from the cathode is then found to have formed a distinctly visible deposit on the wall of the tube. It has likewise produced a slight spot in the center of the crystal disk. Finally, at the point of the crystal which has been struck by the deflected cathode rays, a very slight spot, due, it seems, to the reduction of the crystals, is observed.

If the disk be exposed to mercury vapors, the central spot becomes distinctly visible. Microscopic study then shows the drops of mercury to be far more numerous on this spot, whereas nothing extraordinary is seen in the region V struck by the cathode rays. This is borne out by the microphotographs here shown. Figs. 4 and 5 correspond with the central portion of the spot and show the number of drops per square millimeter to be 21,896 and 23,492 respectively; the third photograph (Fig. 6) taken in the central region comprises 6,565 per square millimeter, whereas only 537 are obtained when photographing the region V struck by cathode rays (Fig. 7).

FIG. 12.—THE APPARATUS EMPLOYED.

The latter rays are thus shown to play no part in the formation of liquid drops, and should be attributed to the projection of material particles. If each of these particles be considered as a center of attraction, giving rise to the production of a drop, a simple means is obtained for estimating the dimensions of those particles. By submitting two portions of the same glass plate to cathode bombardment, first during a sufficiently brief interval of time t for counting the number N of centers per square millimeter, and secondly during a sufficiently long period T for obtaining a deposit of measurable thickness (e millimeters), the volume v of each projected particle is in fact readily found:

$$Nv\frac{T}{t} = e$$

The apparatus in which the cathode bombardment was produced consisted of a glass bulb sealed to a metal plate forming the anode, opposite to which a plane circular cathode 60 millimeters in diameter of silvered brass was placed. The glass plate designed to receive the bombardment was placed on a metal plate rigidly connected with the anode, carrying a steel point on which an aluminium disk with an aperture was placed. An iron plate glued to this disk allows it to be turned round from outside by means of a magnet so as to place the aperture in front of any given region of the glass plate. The anode is connected to the ground so that the glass is inclosed, apart from the portion left free, in a conductive case at the potential zero, which forms a perfect electrical screen.

FIG. 2.—SAME PLATE AS IN FIG. 1 AFTER EXPOSURE TO MERCURY VAPOR.

The plate is marked by a diamond scratch dividing in into two sections. The plate is cleansed with acids and distilled water and glued to the anode.

After producing a vacuum of 0.001 millimeter, the induction coil is started with about five interruptions per second. The operation continues during ten to fifteen minutes, until a constant pressure of about 0.002 to 0.003 millimeter is obtained, which is a very important condition.

The five sections of the plate were exposed simply by placing the aperture in front of each of them. By causing mercury vapors to act on the exposed side of the plate, the different sections are revealed absolutely in the same manner as a photographic plate or a daguerreotype. On examining the plate under a microscope the mercury drops are recognized distinctly, the regularity of their distribution being most striking. The number of drops per square millimeter increases regularly with the time of exposure. Fig. 8 shows a section of the plate submitted to no exposure; Fig. 9 a section submitted during six seconds to the impact of cathode projections; Fig. 10 the result of nine seconds' action; and Fig. 11 the aspect of the plate after an action of fifteen seconds. The number of drops produced by the discharge is practically proportional to the time of exposure.

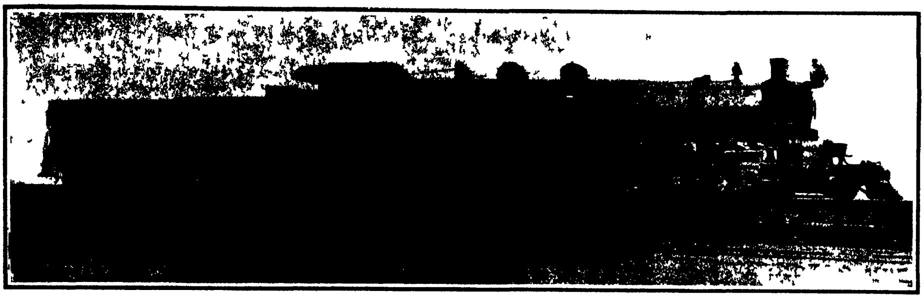
From the above it may be inferred that the number of centers of attraction produced during a given time on a given surface can be readily calculated by means of micro-photographic records. The same experiment allows the average mass of each projected particle to be calculated. The figure found by Houllevigue is 6×10^{-12}.

Supposing, according to Perrin's experiments, a hydrogen molecule to weigh 2.8×10^{-21} milligrammes, the mass of a silver molecule would be 3×10^{-19}. Cathode projections would thus be constituted by material elements twenty million times heavier than molecules.

ENORMOUS LOCOMOTIVES.

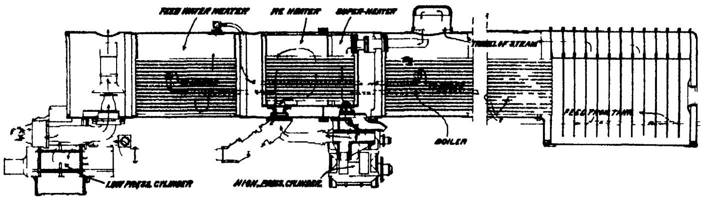
THE TWO NEW MALLET ENGINES IN ENGLISH EYES.

OTHER things being equal, the dimensions of a locomotive engine are fixed by the weight of the train it is intended to haul. But what fixes the weight of the train? This is one of those fluid problems to answer which is difficult, because there are so many unknown independent quantities. To say that it rests with the traffic manager is only to state that which is true in a very limited sense. There is, however, a prevalent belief, whether well founded or not is a point freely enough discussed, that it is cheaper to haul one train than to haul two, each half the size of the one. So far as appears at first sight, the only saving effected is in the wages of drivers, firemen, and trainmen. There are, however, incidental expenses which may perhaps be regarded as being the same no matter what the size of the train, and therefore dependent for the amount solely on the number of trains, and not on their individual dimensions. Under this head may be classed the wear and tear of points and signals, the cost of telegraphic apparatus and of its use, delays due to necessary shunting, and so on. Further more, it is possible that the tare or non-paying load is greater when two trains are used than with a single train. In the United States the principle of one train one engine has been pushed for some years. Locomotives have grown larger and larger, and at last two noteworthy locomotives have been built which are really for the time being at least more monstrous than anything ever heard of before.



Weight of engine and tender 305 tons. Tractive force 26½ tons. Heating surface 4,756 square feet. Steam pressure 2[illegible]0 pounds. [illegible] heating surface [illegible] square feet. Cylinders: Two high pressure 24 inches by 28 inches, two low pressure 38 inches by 28 inches. [illegible]

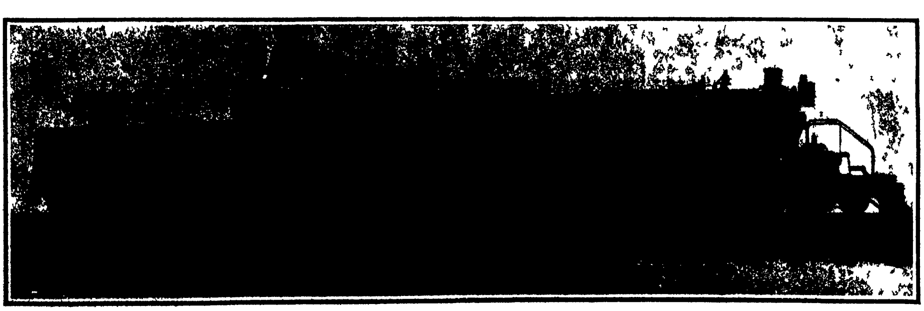
THE MOST POWERFUL PASSENGER LOCOMOTIVE IN EXISTENCE—A NEW TYPE.



[illegible] in the firebox gases which [illegible] its way to the cylinders [illegible]

THE NEW BOILER WHICH SAVES 2[illegible] PER CENT OF FUEL.

The Atchison, Topeka & Santa Fé Railroad system is of enormous dimensions. It runs through the States of Missouri, Arkansas, Texas, Kansas, Colorado, New Mexico and Oklahoma. It has nearly [illegible],000 miles of its own, and affiliated lines bring the entire system up to 8,[illegible]00 miles, or nearly one-third of the length of the railways in Great Britain. In a word, it serves the principal southern States of North America. Mountainous country is traversed by the aid of inclines of great severity. To deal with these much power is required, and for several years the largest locomotives in the world have been found on this railway system. Large as they are, they are held to be too small, and a passenger and a freight engine have been ordered from the Baldwin Locomotive Works for use on the Atchison and Santa Fé section of the system. The first of these, No. 13[illegible], weighs [illegible] American tons with the tender, or [illegible] English tons. Both engines are constructed on a modified Mallet system. The front end of the passenger engine is carried on a four-wheeled truck, and next we have four coupled wheels driven by the low-pressure cylinders, which are 38 inches by [illegible]8 inches. Next come the high-pressure cylinders, 24 inches by 28 inches, turning six coupled wheels. Last of all are two trailing carrying wheels under the fire-box. There are sixteen wheels in all. The driving wheels are 6 feet 1 inch in diameter. The tender is carried on two six-wheeled bogies. The tank holds 1[illegible],0[illegible]0 gallons, or nearly [illegible]4 tons of water, and 4,000 gallons of oil. The freight engine No. 1[illegible]00 differs very little save in detail and certain dimensions from



Weight of engine and tender 350 tons. Tractive force 54 tons. Heating surface 6,6[illegible]1 square feet. Steam pressure 220 pounds. Superheating and reheating surface 1,74[illegible] square feet. Cylinders: Two high pressure 26 inches by 34 inches, two low pressure 38 inches by 34 inches. This locomotive embodies superheating, reheating, feed-water heating and compounding.

THE MOST POWERFUL FREIGHT LOCOMOTIVE. WEIGHT 350 TONS.

A NEW ERA OF THE AMERICAN LOCOMOTIVE.

the passenger engine. At the leading end is a two wheeled truck. Then the low pressure cylinders, 38 inches by 34 inches, turning eight, coupled, wheels Next, the high pressure cylinders, 26 inches by 34 inches, then another group of eight, coupled wheels, and, lastly, a trailing pair under the firebox The total weight of engine and tender is 350 American or 312 5 English tons The tender is similar to that of the passenger engine The freight engine alone weighs 207 English tons, leaving that of the tender 105 tons Confining our attention to this gigantic machine, we have twenty wheels, each pair carrying an average of 20 7 tons No doubt, the weight being unequally distributed, some of the axles represent over 25 tons The working pressure is 220 pounds The so called boiler is a very peculiar structure The barrel is 7 feet in diameter and of enormous length The tubes, over 20 feet long, open into what is termed a combustion chamber in which is a superheater and re-heater combined, and thence to a feed water heater, with 417 tubes, 2¼ inches diameter by 6 feet 8 inches long The total heating surface is 6 621 square feet The great merit claimed for this extraordinary machine is that it will do its work with 25 per cent less fuel than any previously constructed locomotives can do it with. Of course, we have only given the merest descriptive sketch of the engines

We now come to certain considerations connected with their use The tractive effort of the passenger engine is over 23 English tons, that of the goods engine is 48 English tons Allowing 185 tons as the adhesion weight, by deducting 11 tons for each pair of carrying wheels, it appears that in order that this effort should be utilized, the coefficient of adhesion must be not far from 26 per cent, or nearly twice as much as it is safe to reckon on here. Assuming, however, that in some way this enormous effort can be exerted, we ask ourselves what must be the construction of the rolling stock which has to sustain it? Obviously, the stresses cannot be exerted through the wagon frames A continuous drawbar must be employed, to which each wagon is secured either by springs or friction draft rigging But what about the automatic coupler heads?—if, indeed, these are used As to the loads to be hauled, only general statements are available Let us take an incline of 1 in 40 and a gross load of 1,000 tons behind the tender The resistance due to the incline would be 25 tons, and at 6 5 pounds per ton the rolling resistance would be about two tons more, or 27 tons in all, or nearly one-half that which the engine could overcome—on paper This, then, seems if we add 3 tons more for the resistance of the engine and tender, to be about the greatest load the engine can deal with; unless, indeed, as we have said, a coefficient of adhesion is available, unknown in this country

We believe that we are correct when we say that these enormous machines would not have been built were it not for the belief that, as we have stated, they will do their work with an economy absolutely unprecedented Engineers all over the world will look forward with interest to the publication of some definite information on this subject after sufficient time has passed to permit the collection of the necessary data. A similar method of construction may be carried out on a much smaller scale, should it be deemed justifiable It should be kept in mind, however, that the first cost of these colossal locomotives must have been staggering. Being the first of their kind, with all patterns to make, we shall probably not be far off the truth if we say that between them they represent an outlay of $125,000 or $150,000, or, say, $250 per ton for the engine and tender complete in running order.

The interest on such a capital outlay is no trifle Their depreciation and wear and tear and upkeep will probably represent a sum considerably in excess of that required for the same purposes by four engines, each of half the weight. In the absence of detailed information we can only express a qualified opinion But it appears to us that the design is bad in that the cylinder power is much in excess of what the coefficient of adhesion will allow to be utilized. At this side of the Atlantic these engines only possess interest as mechanical curiosities, as no conditions exist under which it would be possible to use them. We have said nothing about the question of bridges and viaducts. We take it for granted that this is a matter which has been carefully thought out by the road engineers We may add that even in this country mistakes have been made in this direction, but no doubt in the United States big risks are taken more freely than in this old kingdom.—Engineer.

THE SAD-IRON AS A DISINFECTOR.

HOW IT STERILIZES LINEN.

BY PROF. K. SVEHLA.

The prevention of contagious disease presents many and almost insuperable difficulties to the practising physician especially in rural districts One of the first conditions to be satisfied by a physician treating cases of contagious disease is that he shall not himself carry contagion to other patients In my private practice I formerly endeavored to satisfy this condition by the following means

After every visit to a patient suffering with a contagious disease I went home and changed my outer garments and often my underclothes also The suit of clothes was kept by itself in a special closet, and worn only in visiting the same patient, or another patient afflicted with the same disease If I had several contagious diseases under treatment at the same time I always kept a special suit for each disease When the treatment of the case was concluded, the suit was disinfected by formalin vapor in an air tight cabinet By this method I have hitherto avoided introducing any contagious disease into my own family or, I hope, that of any of my patients It is, therefore, a good method of preventing contagion, but it is also a very troublesome method A great deal of time is wasted in dressing and undressing, and in coming home after each visit to a patient The method is also very expensive and, for all of these reasons, it would be almost impossible for a physician having a very extensive practice

In order to simplify the process I began to wear, when visiting a case of contagious disease, a long linen gown which entirely covered my other garments. This gave security for the first visit but before the second visit it was necessary to sterilize the gown, in order to prevent the possibility of its contaminating my other garments This danger is especially great in some exceedingly contagious diseases, such as scarlet fever in which we are yet ignorant of the nature of the germ and the method by which it enters the organism

In many households sterilization by steam or by boiling was useless, as it could not be properly performed I therefore sought a more convenient method of sterilizing, and ironing suggested itself as peculiarly appropriate

For the purpose of testing the efficacy of ironing as a preventive of contagion, I made a series of experiments, in the hygienic laboratory of the Bohemian University of Prague

In these experiments I employed four hollow sad-irons of different types The first was heated by an inclosed mass of red hot iron to 385 deg. F., the second by glowing charcoal to 428 deg F., the third by a gas flame to 464 deg F, and the fourth by an alcohol flame to 752 deg F while the flame was burning and 594 deg F. after it had been extinguished. These temperatures were measured before the commencement of the experiments Very hot irons cannot be used, on account of the danger of scorching the garments The results obtained with the four irons were substantially the same.

I used a variety of fabrics, including linen, woolen, and cotton cloths of various textures, fine lawns, velvets, flannels, and materials used in making men's and women's garments Every grade of thickness, from the lightest to the heaviest, was represented These fabrics were artificially infected in various ways by dipping them in contaminated water, by using them as dust cloths, by laying them in the beds of children suffering with various contagious diseases, by daubing them with pure cultures of the bacilli of typhoid, diphtheria, dysentery, etc., and by applying purulent matter to them In every case a bacterial examination of the fabric was made before and after the experiment In this way about 200 experiments were made, with the following results

A single application of the hot iron sterilizes all fabrics superficially, and lawns, fine napkins, handkerchiefs, etc, throughout their thickness. The sterilizing effect diminishes as the thickness of the cloth increases Heavier fabrics, such as the Russian linen of which my protective gowns were made, must be ironed at least twice on each side, in order to sterilize the interior The hot iron may be passed ten times over one side without effecting complete sterilization Very heavy woolen cloth cannot be thoroughly sterilized by ironing, by any method adapted for practical use

In sterilizing materials as thick as Russian linen, which require the application of the iron to both sides, the ironing table must be ironed before the fabric is turned over, in order to prevent the table from conveying contagion from the unironed to the ironed face of the cloth. Fabrics which would be injured by direct application of the hot iron can be sterilized superficially by covering them with thin, moistened linen and ironing this until it is quite dry

It might be imagined that superficial sterilization is of no practical value For this reason I made an investigation of the depth to which such materials as velvet and flannel are infected by germs applied to the surface. I found that the infection remained purely superficial for a considerable period. Hence it may be assumed that, in most cases, the infection of garments by contact with the body of the patient or with sputum or pus is confined to the surface, and that all danger can be averted by ironing.

These experiments show that ironing is an easy and also an effective method of sterilization.

I now wear, in the presence of patients suffering with contagious diseases, long linen gowns, which are sterilised by ironing after each visit. The simple task of ironing can be required of every family and, in my experience, it has always been willingly and satisfactorily performed. It would be to the interest of every family to provide such a gown for the use of the family physician and to sterilize it by ironing after each visit. I believe that this innovation would be welcomed by all conscientious physicians, and would give the family an inexpensive safeguard against contagion.

The experiments also demonstrate the great hygienic value of ironing, in general. We come very frequently, and unwittingly, into contact with infectious matter, and our clothes are contaminated by coughing, sneezing, etc We can protect ourselves and our families from disease by having our outer garments, as well as our underclothes, frequently and thoroughly ironed —Translated from Umschau

VELOCITY OF EXPLOSION OF GASEOUS MIXTURES.

Although the explosion of a mixture of gases is accomplished very rapidly, it does not take place simultaneously in every part of the mass, but is propagated from point to point with a definite velocity The measurement of the velocity of the wave explosion has formed the subject of numerous researches. The German chemist Ernich has devised a lecture experiment by which the existence of a finite velocity of explosion can be shown, and the velocity measured A steel tube about 30 feet long, with an internal diameter of 4 inches, is coiled up so as to occupy a minimum space, and its ends are brought within a few inches of each other and bent upward. Each end is provided with a cock, and to one of them is attached a device for igniting the contents of the tube by means of an electric spark. Above the ends of the tube a horizontal disk is mounted on a vertical axis, which can be caused to rotate at a known velocity—say 50 revolutions per second. The under side of the disk is covered with thick paper which is coated with lamp black. The apparatus is arranged so that the centers of the two ends of the tube are directly beneath the same radius of the disk. The tube is filled with an explosive mixture of gases, both cocks are opened, and the mixture is fired by an electric spark A tongue of flame appears to dart at the same instant from each end of the tube, but the two white patches on the blackened paper, which mark the places where the lampblack was swept away by the outrush of burning gas, are found to lie on different radii of the disk. From the angle between these radii, the velocity of the disk and the length of the tube, the velocity with which the explosion travels along the tube in that particular explosive mixture can be computed with a fair degree of accuracy.—La Nature.

* * *

Although the use of telephones in mines is not of recent origin, states a contemporary, the advantages are, perhaps, hardly really appreciated until they have once been tried. Probably at no time in the history of mining has there been a greater demonstration of the great need of telephones in mines than at the Cherry coal mine disaster, in the United States. How many more lives could have been saved had the mine been fully equipped with telephones is entirely problematical, but it is certain that the number would have been greater had opportunity been afforded for communication between the rescuers and the entombed men.

Correspondence.

CARTAGENA--THE HEROIC CITY.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT

I HAVE been reading with much interest the account of Cartagena which appears in the SCIENTIFIC AMERICAN SUPPLEMENT of January 22nd 1910 the more so as I have been recently studying the various accounts of the British attack on that city in 1741. On page 57 you give a picture of Fort San Felipe where according to the title Vernon's troops were defeated. I think this is a mistake. It was at Fort St Lazar that they were repulsed. Fort San Felipe was on the island of Tierra Bomba which was occupied at the commencement of the attack. The picture entitled "The Oldest Fortress in America" on page 57 looks to me as if it might be St Lazar. It would be very interesting to me if you could find out that this is so.

Possibly the following few items about the American troops engaged may be of interest and also the little photograph of an old plan of Cartagena which is in the British Museum.

When war was decided on with Spain six regiments of marines were specially raised for Vernon's expedition and prior to its departure were encamped in the Isle of Wight. This was late in 1739 and in the year following according to Cannon's Records of the Royal Marine Corps "an additional regiment of four battalions was authorised to be raised in America & the royal standard was erected at New York as the signal post to which every volunteer marine was to repair. The field-officers & subalterns were appointed by the King & the captains of companies were nominated by the American provinces. Colonel Spotswood of Virginia was appointed colonel commandant of the whole. It was supposed that from climate the natives of that continent were better calculated for the service to which they were destined than Europeans. Their uniform was camlet* coats brown linen waistcoats & canvas trousers. This regiment which was afterwards commanded by Colonel Gooch was considered as the Forty Third regiment of infantry of the line."

Elsewhere we read in a contemporary notice "Three regiments of foot of a thousand men each are raising with all speed in our American Colonies & will consist of natives or those inured to the climate. The Colonels Lieutenant Colonels Majors & Subalterns are appointed by His Majesty & their general rendezvous is to be at New York where the Royal Standard is set up. Their clothing is to be made here which is camlet coats brown linen waistcoats with two pair of canvas trousers for each man."

"The American companies were chiefly raised by the interest & at the charge of their respective captains of whom were members of the assemblies in the provinces where they resided others lived upon their own plantations & had commands in the Militia. His Majesty was pleased to send to New York thirty young gentlemen under the direction of Brigadier Blakeney to serve in the corps as lieutenants they had carried arms either in the old corps at home or in the Scotch Regiments in the Dutch Service & were most of them cadets of good families in North Britain. The men were principally Irish Roman Catholics."

The regiments under Col Spotswood joined Vernon's expedition at Jamaica on February 2 th 1741 and also a body of negroes who had been specially enlisted. Few American troops appear to have been landed until the outer harbor and the defenses at the entrance of the inner one had been captured but two battalions of them with other troops were put on shore near St Lazar on the 6th of April three days prior to the unfortunate attack on that fortress. The troops detailed for the assault consisted of 500 men drawn from the grenadier companies of the various regiments under Col Grant of the Fifth Marines 1,000 marines under Col Wynyard of the Fourth Marines—probably his own battalion and a body of Americans who were sent into action without arms in order that they might carry scaling ladders wool packs to fill the ditch and hand grenades.† Brigadier Guise was in charge of the whole. As the attack had not been properly prepared for by bombardment and by a proper reconnaissance of the ground to be passed over by the attacking columns some of which lost their way and came under a heavy flank fire from trenches of whose very existence they were ignorant the assault was almost foredoomed to failure. The following is from an old report of the engagement. "The persevering & undaunted bravery of British Soldiers were never more displayed than on this day. They at last gained their points by intrepidly leaping into the entrenchments & driving their enemies into the fort which communicated by a drawbridge with the lines. Cooped up within a narrow spot exposed to the grape shot & marksmen of the enemy above them the situation of these brave remnants became desperate after the break of day. The unarmed Americans in the rear many of whom were killed without possessing the power of resistance dispersed throwing away the charges committed to them." It should be added that there was a brilliant exception to this for three of them in spite of the panic and confusion bravely pushed forward on their own with a ladder by means of which a sergeant and a couple of men actually mounted to the summit of St Lazar's ramparts but only to be cut to pieces. The decimated stormers hung on in the bullet swept space between the outworks and the fort itself till they received the order to retire and were only extricated from a counter attack made by the garrison of Cartagena by the advance of the First Marines under the command of Col Wolfe—the father of the hero of Quebec.

The Americans loss must have been heavy as only 23 re-embarked out of the two battalions that were landed including 286 who were sick. The expedition afterward transferred its energies to Cuba and we find Capt William Hopkins of the American regiment issuing a proclamation for volunteers to enter offering grants of land to all such families as were disposed to settle in that island. War and disease appear to have played havoc with these regiments inured as they were supposed to be to the climate for in a return of their numbers (exclusive of officers) issued October 7th 1741 we find that the four battalions of Gooch's Americans between them only mustered as fit for duty 210 sergeants 197 corporals 74 drummers and 1,610 rank and file. It would appear very doubtful if more than a very small percentage of the men were Americans at all for the Irish Catholics which it is said so many of them were were not probably in very great abundance in the American provinces at that date.

PLAN OF CARTAGENA

Royal Marine Barracks Chatham Col C Field

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* A species of rough material a mixture of cotton and wool

† As many of the American soldiers were suspected to be Irish Papists it was thought admirable both by the General and Admiral to employ them principally aboard the fleet.—A Journal of the Expedition to Cartagena.

WATER-GLASS CEMENTS

WITH all water glass (soluble glass) cements the principal point to be attended to is to first heat the article to 212 deg F and then apply the water glass previously liquefied by heating with a warm brush to the surfaces which are to be cemented the latter must be pressed closely together or if necessary held in position by a cord tied round them. After drying for twelve to fourteen days at a moderate temperature the cement will be quite hard.

Cement for gas and water pipes is composed of water glass and amorphous silicic acid.

Cement for stone glass and porcelain. According to Schwartz a very hard drying cement can be obtained from manganese zinc white and water glass solution. Another good cement for these substances can be made by mixing powdered asbestos and soda water glass solution. The articles to be cemented should be moistened before applying the cement with liquid sodium silicate and any cracks appearing during drying filled up with some of the cement slightly diluted. A good cement for glass and porcelain can also be prepared from 1 part of very finely ground and washed flourspar and ¼ part of finely powdered glass with ½ part of soda water glass solution of 16 deg Bé these substances being mixed to a rather thickish mass. A thin layer of the mass must be rapidly applied to the surface to be united and the parts pressed together. In a few days the cement will have become very hard.

For stone.—To cement stone Lielegg uses a mixture of hydraulic lime and water glass.

Water glass cement for iron and wooden water tanks pails etc.—These latter if they are leaky or if holes in the iron have been caused by rust can be rapidly and easily again rendered water tight by applying a cement prepared from water glass and amorphous silicic acid coating the articles in question with a warm brush and drying the parts each time with the flame of a soldering lamp which is done in a few seconds. The application should be repeated till the cement has formed a kind of crust over the spot where the crack or the hole was.

For steam pipes.—For cementing steam pipes instead of wrapping them in straw, which is apt to become rotten and to burn away a very effective preparation is a mixture of chalk or lime dust and cow's hair or chopped straw with water glass.

For windows.—A mixture of chalk and water glass specially prepared for this purpose is the most reliable kind of putty for windows and preferable to the putty made of chalk and linseed oil hitherto used. Apart from the low cost this water glass putty has the advantage of drying in a few hours without any odor. Care should be taken however not to prepare more of the material than is required for the articles in question otherwise it will become hard.

NEW INVESTIGATION OF THE RAINBOW

ONE would think that every child would know how the rainbow looks but that is by no means an incontrovertible fact. The question is solved so slightly by any answer that suits all cases that savants never tire of making it the object of further investigation. They determine with the latest results of their research that the appearance of the rainbow is endlessly various but do not succeed in reproducing the colors of the rainbow with evident precision. They hope to attain better results with the new photographic systems.

Since Newton (1704) it has been assumed that the rainbow in the falling drops of rain is produced in the same way as a bright strain of light when sunshine falls on a prism. The fact is however that sunlight can never properly be called white since the sun shines in a yellow mixed color which together with the blue light of the sky gives the white light of day. The mixed color produced from the light of the rainbow does not always bear some resemblance to white for the reason that as the sun sinks at the horizon it steadily loses a greater measure of its violet blue and green rays and in fact the appearance of the rainbow changes within fair boundaries. When the sun rises and sets rainbows contain often only red rays and rainbows colored with red and orange are no infrequent phenomena indeed. With great frequency secondary bows are formed about the red rainbow which are far from being in consonance with the sequence of color. When diffraction occurs light of a given color gives a sequence of concentric bright bows which are separated by bright streaks. The outermost bow is much the brightest and the successive inner or secondary bows rapidly show a diminished light. The distance of the bright rays from one another is by so much greater the smaller the drops are by which the light is diffracted. At the same time the bows are broadened their light is weakened and their diameter decreased. The outermost and brightest bow of every color disposes itself in accordance with the order of the spectrum with the corresponding bow of other colors but covers them in a measure and by so much more the smaller the drops are so that mixed colors appear. This occurs oftener among the secondary bows which have almost a pure full color. If the rain drops have a radius of 0.1 millimeter the first secondary sequence of color mingles with the inner violet parts of the chief bow and destroys the order of color as well as the distinctness of the secondary bows. Drops of medium size with a radius below 0.1 millimeter give a rather regular sequence of color as chief bow in which blue is often not recognizable then a dark interval and thereafter secondary bows mostly in the mixed colors purple and whitish green. If the drops are very small say with a radius below 0.03 millimeter all the colors mingle and the rainbow appears white only its outer border remains tinged with uncertain brown to yellow while its inner border has a violet cast. The bow is then broad and weak and the likewise white secondary bows seldom are seen. Consequently it follows that the appearance of the rainbow is infinitely various in accordance with the ever different size of the drops of rain.

Most of the penny in the slot machines are worked by victimized power that is power derived from the patron or victim. The patron furnishes the muscle that works the mechanism as well as the cent that releases the operating machinery. Strange to say the element of action on the part of the user is an important factor in the success of some of these machines. It appears that many of the users of these machines enjoy pulling a lever they somehow feel that they are getting more for their money than if they simply pressed an electric button. A certain fortune telling machine was first put out with an electric motor driving the machinery. The patron only had to deposit his coin and place his hand on a slab in which there are many projecting studs to have his fortune told. The machine did not prove to be a money puller. The motor was discarded and a long lever was substituted which must be pulled each time a fortune is told. This machine yields a handsome income. The experience adds to our knowledge of the curious phases of human psychology.—Machinery.

HALLEY'S COMET AS SEEN FROM THE EARTH.*

THE POSITION OF THE COMET.

BY P H. COWELL.

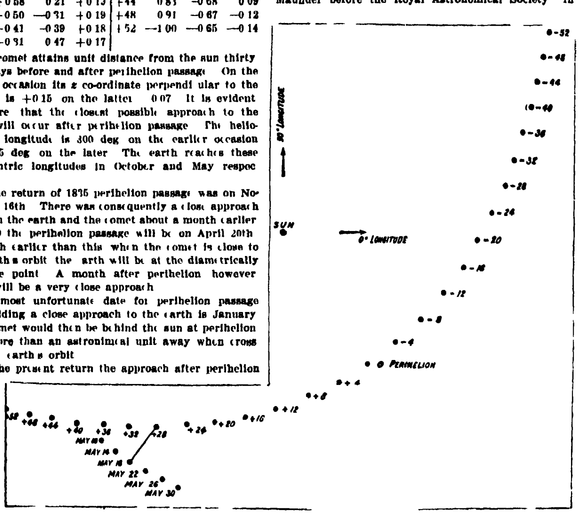
The following table gives ecliptic co ordinates of Halley's comet to two decimal places at intervals of four days through an arc extending from one end to the other of the *latus rectum* of its orbit The zero of time is very nearly the moment of perihelion passage and the figures apply approximately to any return

Day	x	y	z	Day	x	y	z
−52	+0 95	+0 73	+0 12	+ 4	+0 21	−0 54	+0 15
−48	+0 93	+0 64	+0 13	+ 8	+0 10	−0 59	+0 13
−44	+0 91	+0 55	+0 14	+12	0 02	−0 64	+0 11
−40	+0 89	+0 46	+0 15	+16	−0 13	0 67	+0 09
−36	+0 86	+0 37	+0 16	+20	−0 24	−0 69	+0 06
−32	+0 83	+0 27	+0 17	+24	0 34	−0 70	+0 04
−28	+0 80	+0 18	+0 18	+28	0 45	0 71	+0 01
−24	+0 75	+0 08	+0 18	+32	0 55	0 71	−0 02
−20	+0 70	−0 02	+0 19	+36	−0 64	−0 70	−0 04
−16	+0 65	−0 12	+0 19	+40	−0 74	−0 70	−0 07
−12	+0 58	0 21	+0 19	+44	0 83	−0 68	0 09
− 8	+0 50	−0 31	+0 19	+48	0 91	−0 67	−0 12
− 4	+0 41	−0 39	+0 18	+52	−1 00	−0 65	−0 14
0	+0 31	0 47	+0 17				

The comet attains unit distance from the sun thirty nine days before and after perihelion passage On the former occasion its z co-ordinate perpendicular to the ecliptic is +0 15 on the latter 0 07 It is evident therefore that the closest possible approach to the earth will occur after perihelion passage The heliocentric longitude is 300 deg on the earlier occasion and 225 deg on the later The earth reaches these heliocentric longitudes in October and May respectively

At the return of 1835 perihelion passage was on November 16th There was consequently a close approach between the earth and the comet about a month earlier In 1910 the perihelion passage will be on April 20th a month earlier than this when the comet is close to the earth's orbit the earth will be at the diametrically opposite point A month after perihelion however there will be a very close approach

The most unfortunate date for perihelion passage for yielding a close approach to the earth is January The comet would then be behind the sun at perihelion and more than an astronomical unit away when crossing the earth's orbit



The diagram gives the position of the earth for six days in May also the position of the comet on twenty seven dates measured from perihelion passage in days The line of sight is drawn for May 18th twenty eight days after perihelion when the comet transits across the sun

On the present return the approach after perihelion will be unusually close The following table gives the ecliptic co ordinates of the earth for the annexed dates

Date	x	y
1910 May 10th	−0 65	−0 76
1910 May 14th	−0 60	−0 80
1910 May 18th	−0 55	−0 84
1910 May 22nd	−0 49	−0 87
1910 May 26th	−0 43	−0 90
1910 May 30th	0 37	0 93

When therefore the comet crosses the plane of the ecliptic twenty eight days after perihelion passage (May 18th) it will be almost exactly between the earth and the sun and the earth will probably be in the tail of the comet

The closest approach at this return takes place a day or two later

The closest approach possible would correspond to a perihelion passage about a week and a half earlier in the year than the present one

It appears therefore that the date of perihelion passage at this return is most fortunately timed and a fine display may be expected

The comet's history has been traced back to 240 B C and it has very seldom returned to perihelion unrecorded so seldom in fact as to suggest that in the exceptional cases the records have perished rather than that the comet in any circumstances can pass by unseen

A tail twenty or thirty degrees in length is expected on the present occasion It will be best seen at the end of May and in England it will unfortunately be lower in the sky than in more southern latitudes There will however be no difficulty whatever in seeing it in England unless there is a prolonged spell of bad weather

The approach to the earth is so close that an American astronomer has conceived the idea of weighing the comet by the deviation it produces in the orbit of the earth We can hardly believe that the effect produced will be one thousandth part of the least measurable quantity but the speculation is most interesting in view of the fact that there are unexplained phenomena in planetary movements

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* Nature

RECENT STUDIES OF MARS

Perhaps the most distinguished of European Martian observers is E M Antoniadi whose name figured prominently in the recent discussion provoked by E W Maunder before the Royal Astronomical Society In the Comptes Rendus Antoniadi presents some observations of Mars made at Meudon The planet was studied with the 0 83 meter telescope with magnifications 320 470 and 800 diameters on thirteen nights from September 20th to November 9th Among the most remarkable changes noticed since the opposition of 1907 were the return of Syrtis Major to its form of 1864 and 1877 the reappearance of Lac Mœris and the formation of a multiple island in the eastern region of the Mar Cimmerium At the same time the planet was partly veiled by mists or light cirrus which lightened the indigo-gray tone of the seas and gave a yellowish hue to the continents The tint of these mists or cirrus varied according to their intensity from golden yellow to dull white Their effect sometimes in almost obliterating spots which had appeared black a few days earlier was very remarkable Some fifty canals were observed Adopting Schiaparelli's definition of a canal as a grayish band or line in the regions called continental assuming all kinds of forms and longer than the more or less elliptic spots called lakes Antoniadi proceeds to divide the canals into eight classes The list does not include the fugitive straight lines often also called canals which are visible only a fraction of a second and may be illusory The observations do not confirm the existence of a geometric network of straight lines crossing in all directions

Photography of the planet Mars was recently discussed before the French Academy of Sciences by A de la Baume Pluvinel and F Baldet The photographs exhibited were obtained at the observing station on the Pic du Midi with a new double instrument comprising a reflector and a refractor (diameters 0 50 and 0 25 meters focus 6 meters) on a very steady mounting The focal image of Mars being only 0 8 millimeters diameter an enlarging lens was employed giving disks of 3 to 5 millimeters diameter During September and October 80 plates with 1 350 images were obtained At first Lumière violet and Guilleminot lactate of silver plates were used, but soon abandoned as they rendered the ruddy surface of the planet uniformly gray without any detail They show the polar caps distinctly however The southern cap is much reduced but very brilliant at the north pole on the contrary a region of the cap is seen which is rather far from the pole and deficient in brightness The eastern border of the planet is brighter than the rest of the disk After the first trials a yellow screen was placed behind the magnifying lens and plates sensitive only to the rays passing through it were employed Under these conditions the Martian snows act feebly on the plate the south cap is still fairly intense but the north cap and also the white border on the eastern limb are invisible On the other hand the contrasts between the Martian lands and seas are very apparent and a considerable amount of detail is shown The canals of the first order are visible on the photographs such as Indus Ganges Axarxes etc No trace appears of the geometric network of fine lines seen by certain observers the existence of which is disputed

HAS THE CLIMATE OF NORTH AFRICA CHANGED SINCE THE ROMAN PERIOD?

The fact that most forcibly impresses the traveler in Tunis Algeria and Morocco is the great development which Roman civilization attained in those countries This fact is particularly striking in Tunis and in the province of Constantine in Algeria which are filled with ruins of large Roman cities extensive aqueducts and other works The contrast with the poverty of the present inhabitants and the sterility of the ill cultivated soil makes these evidences of former prosperity still more impressive It has often been suggested that a change has taken place in the climate of North Africa and that this alteration in the aspect of the country has been produced by a decrease in the rainfall and an elevation of the mean temperature of the region

Gen de Tiamothe came to the conclusion according to Cosmos that the climate of Algeria was marked by violent contrast even before the appearance of man on the globe during the geological periods of the pleistocene and the upper pliocene and that the distribution of rainfall through the year was as unequal then as it is now

A very long interval of time however extends between the pleistocene and the present epoch and it would be interesting to know the character of the climate of North Africa during the flourishing Roman period Dr Leiter has endeavored to obtain this knowledge from historical data

From such information in regard to the climate of the Mediterranean region as is given by Greek and Roman writers, it is impossible to draw any evidence that a change has occurred in the mean annual temperature the fluctuations of temperature the pressure of the atmosphere the directions of the prevailing winds or the amount of rainfall The persistence of the cultivation of certain crops proves that the climate has not changed The crops are evidently smaller than they were in Roman times but this is due to the negligence of the present inhabitants

The felling of forests could not have greatly altered the climate of so extensive a region From the data which we possess in regard to the extent of the ancient forests it appears that the removal of lofty forests has been confined to the present territory of Algeria. Nor do the changes which have taken place in the fauna of the country indicate that the climate has become hotter or dryer The disappearance of large mammals and the subsequent introduction of the camel have resulted from man's invasion of the region

It should be observed however that Dr Leiter's conclusion that the climate of North Africa has not changed since the Roman period is at variance with those derived by Gautier from his travels in the Sahara and by Freydenberg from his study of the country about Lake Tchad There can be no doubt that the climate of each of these regions has gradually become dryer

HOW THE FLORA BUST WAS STUDIED.

THE COLORS OF THE BUST IN THE BERLIN MUSEUM

BY PROF. E. RAEHLMANN.

The question of the genuineness of the bust of Flora in the Kaiser Friedrich Museum in Berlin is intimately connected with the question of its antiquity To me was assigned the task of ascertaining whether any reliable indication of the age of the bust could be obtained from the character of the pigments with which its surface is colored The investigation was carried on with the aid of the microscope

Small fragments which have become detached from the surfaces of paintings can be satisfactorily examined with a power of 200 diameters if the illumination is good especially when fresh surfaces of fracture are exhibited On these surfaces it is possible to distinguish the successive coats of paint which differ in color density and refrangibility

It is often possible to distinguish in the same way the ingredients of a single coat of paint This determination is particularly easy when the pigment is not dissolved but consists of fine solid particles suspended in a transparent medium Then it is possible to determine both the character of the medium and that of the pigment The latter is identified by the size of the grains their degree of transparency and their form Sometimes it is possible to determine the period in which the picture was made pretty accurately from the character of the medium and the optical and chemical behavior of the pigment I feel confident that, with a further development of the method of investigation which I have employed shall ultimately be able to prove or disprove the authenticity of a picture by comparing the work with other paintings of the same epoch attributed to the same artist

In the old days every art period had its characteristic technique which depended upon the education of the artist in studios schools and guilds The Italian Dutch and German painters of the Renaissance epoch employed mediums which they prepared with their own hands in accordance with traditional secret formulas A close comparative study of old paintings indicates however that the artists of all these countries knew and used the same or nearly the same medium

To this medium these old pictures owe their permanence and the eternal beauty of their colors With the disappearance of the art schools and guilds the formula of this medium was lost Various substitutes were employed successively until the substances now in use were introduced

When the surface of fracture of a freshly broken fragment of a painting of the Renaissance period is examined under the microscope with a power of about 50 we see a medium of peculiar transparent homogeneous structure which presents an appearance entirely different from that of a fragment of a painting made within the last one hundred years The character of this medium can be made out more clearly when it is colorless that is to say when it contains only insoluble solid particles of pigment and is not stained by dissolved pigments In old pictures this condition is found especially in the blues (ultramarine and cobalt) and some of the reds (vermillion, red lead madder etc) whereas the green and yellow pigments which were then employed were for the most part dissolved in the medium which they consequently stained throughout Hence the old painting medium can best be studied in the blue and red parts of the picture According to my experience, the best objects for study are blue articles of clothing in old paintings and carved wood figures of the thirteenth, fourteenth, and fifteenth centuries In all of these cases the medium is of a brilliant pale gray color, transparent in thin layers, and the pigment grains are seen completely imbedded in it With a magnifying power of 200 or more, this medium is seen to be finely granulated When a fragment of the surface of a painting of the fifteenth or sixteenth century is compared with one of the eighteenth or nineteenth century the contrast is very striking The modern fragment is far less transparent than the old one and is often quite opaque almost entirely concealing the pigment grains except those which are actually on the surface

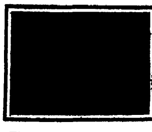

Fig. 1. Light Blue Pigment Layer Seen from the Back, and Bent to Show Cross Section.

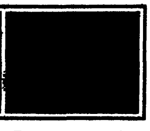

Fig 2 Surface of Bust, Showing Large Red particles Imbedded in the Gypsum

In accordance with this change in the medium the layers of paint have gradually become thinner and thinner in modern times In glazes this modern medium can be employed only in extremely thin layers while old paintings show glazes which are quite thick but which are yet sufficiently transparent to allow the underlying color to show through them

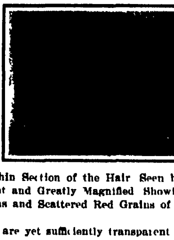

Fig 3 Thin Section of the Hair Seen by Transmitted Light and Greatly Magnified Showing Brown Lichens and Scattered Red Grains of Madder

In the determination of the technical construction of old paintings it is necessary to consider in addition to the layers of paint the so called ground or first coat which serves to attach the pigment layers to the canvas wood or plastered wall upon which the painting is executed In old paintings this ground layer is very thick and it is composed of various substances the knowledge of which was handed down by tradition in the various art schools This pasty foundation is very similar to the outside layer of antique wall paintings from which it was very probably derived The character of the ground layer differed somewhat according to the character of the material wood canvas plaster etc upon which the painting was made In the bust of Flora the ground was determined by the coating of wax below it

I received a number of small fragments of the bust of Flora which has given rise to so much discussion My task was to examine these tiny fragments from the points of view explained above and to compare them with the large number of fragments of art works of the Renaissance period which were in my possession The fragments of the bust of Flora were especially suitable for this investigation because the painting is made on pure white wax The first idea which suggested itself was that wax had also been used as the painting medium or vehicle but it was found impossible to melt the pigment layer on a microscope over a glass flame This experiment proved that the pigments were mixed with a special medium although they were applied to a surface of wax In the subsequent investigation this peculiarity was found very convenient because it made it easy to detach the colors from the wax by immersing the fragments in ether After several changes of the ether the pigment layer separated completely from the wax so that its under surface could be examined

When the colors of the garment are thus examined from the back of the pigment layer they reveal a grayish white substratum of considerable thickness composed of two distinct layers The under layer in contact with the wax is thin and contains fine fibers Microchemical examination revealed the existence of a large proportion of albumen in this substratum (Fig 1) Above this albumen ground is the pigment layer of the blue garment In other fragments of darker blue color a brownish red layer intervenes between the gray ground and the blue pigment layer In other words, different grounds were used for light blue and dark blue

The blue pigment itself is used in the form of coarse grains of various forms some rounded others angular These grains are imbedded in a peculiar transparent medium, which shows fine granulation when magnified 200 times Hence this medium is very similar both in appearance and optical behavior, to the old transparent mediums which I have already described The distribution of the pigment in angular grains furthermore is identical with that of the grains of blue pigment in paintings of the Renaissance period The fragments of the bust of Flora exhibited a particularly close resemblance to fragments of a painting by Marco Basaiti a contemporary of Leonardo di Vinci and also to the blue parts of wood figures of the preceding period The method of applying the pigment blue on reddish brown for example is quite similar to the methods of the Renaissance painters

In order to study the brown color of the hair of the bust I separated portions of the pigment layer from the wax and examined them with the microscope Even with a low power I discovered that the pigment was of vegetable origin and derived from a lichen (Rocella) The coarsely ground lichen served as the brown pigment and the reddish tint of the hair was given by the addition of a transparent red color probably madder in grains and large flakes Thin parts of the pigment layer of the hair mounted in Canada balsam exhibited the structure of the lichen very distinctly (Figs and 4) These lichens which grow on the shores of Corsica and the Canary Islands were much used in painting in the middle ages but were later employed almost exclusively under the names of archil and cudbear in wool dying Madder in very large particles was extensively employed in old paintings but it is now ground very fine or dissolved in the medium The lichen pigment found in the hair proved to be identical with the brown pigment mentioned above which underlies the dark blue of the garment

Small fragments of the bare surface of the bust proved upon microchemical investigation to be composed chiefly of gypsum In places the brilliant white surface is diversified by coarse grains and lumps of a red pigment probably madder half concealed by a thin layer of gypsum (Fig 2) Particles taken from all parts of the surface of the bust show traces of forcible removal of the color by scraping washing etc as well as unmistakable indications of attempts at restoration In some places the wax is quite bare

The details of this painting show careful elaboration especially in the blue garment and a technique which is characteristic of Italian painting in distemper of the fifteenth and sixteenth centuries and German and Dutch works of the same period Some of the materials employed especially the medium have not to my knowledge been used in painting within the past 1 0 years—Translated for the Scientific American Supplement from Umschau

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Interesting tests of the porhydrometer have been recently made in Liverpool It is an instrument for indicating the weight of cargo loaded into or unloaded from a ship It consists merely of a float or areometer connected to a steelyard weighing machine and immersed in a chamber filled with water the chamber being in communication with the outside of the ship The ship rises or falls as the cargo is removed or placed on board and the level of the water in the chamber falls or rises correspondingly so that the float is immersed to a greater or less depth with a consequent alteration in its apparent weight This alteration in apparent weight is read on the weighing machine and from it the weight of the cargo is determined In order that the reading of the apparatus may not be affected by the trim of the ship it is necessary that it be fixed directly over the keel and in the plane of rotation of the hull which generally will correspond approximately with the center of the ship Also it is necessary that the over all length of the float and its chamber be greater than the total vertical movement of the ship between the light and the fully loaded conditions The appliance is of a very simple nature and there should be no difficulty in fitting it to existing ships The inventor claims that it has been officially approved by the Italian government customs.

Fig 4 The Lichen Pigment Washed to Remove the Ry Grains etc

THE NEW CANALS OF MARS.*

RECENT DISCOVERIES AT FLAGSTAFF.

BY PERCIVAL LOWELL.

The word new when applied to a celestial phenomenon may be used in either of two senses It may mean new to earthly observation i e one which has never been seen by human beings before or secondly new in itself that is one which has had no previous existence New canals on Mars in the first sense though always interesting and at times highly important are no novelty at this observatory inasmuch as some four hundred have been discovered here in the last fifteen years When Schiaparelli left his great work he had mapped about 120 canals with those detected here since the number has now risen to between five and six hundred Each of the four hundred thus added to the list however rich an acquisition at the time it first came to be noticed was not necessarily otherwise remarkable

To observe however a canal new in the second meaning of the word one that is that had never existed anteriorly and to prove the fact is an astronomical detection of far reaching significance for the bearing it has upon the whole Martian question

On September 30th 1909 when the region of the Syrtis Major came round again into view after its periodic hiding of six weeks due to the unequal rotation periods of the earth and Mars two striking canals were at once evident to the east of the Syrtis in places where no canals had ever previously been seen Not only was their appearance unprecedented but the canals themselves were the most conspicuous ones on that part of the disk They ran one from the bottom of the Syrtis (lat 20 deg N long 285 deg) the other from a point part way up its eastern side (lat 17 deg N long 281 deg) and curving slightly to the left as they proceeded south converged to an oasis itself new on the Cocytus (lat 5 deg N long 26 deg) about two thirds of the distance to where that canal meets the Amenthes The Amenthes itself was not visible except possibly as a suspicion With the two main canals were associated several smaller ones and at least two oases which had never been seen before and from the interconnection of all of them these clearly made part of the new piece of Martian triangulation

The phenomena were recorded in many independent drawings by Mr E C Slipher and the director and in the course of the next few days were photographed appearing on the plates to the eye as the most conspicuous canals in the presentment of the planet It is opportune that detailed photography of Mars in Mr Lampland's skillful hands should have been so perfected as to make this possible for the photographs taken by both Mr E C Slipher and the director record the canals so that anyone may see them There are thirty images more or less on each plate and the canals appear on every image on some more distinctly than on others owing to the state of our air at the time but recognizably on all for each image had a pose of about two seconds and a half and its definition varied according to the seeing at the time Owing to the grain of the plate being much coarser than that of the eye the two canals appear merged in one in the photographic images as a single line its linear character however being quite distinct to one of good eyesight

All photographs of this region taken in 1907 show no such feature

No remembrance of ever having seen them before could be recalled by either observer both being familiar with the planet except that Mr Slipher turned out to have drawn one of them the evening previous

The record books were then examined when it appeared that not a trace of them was to be found in the drawings of August July June or May when this part of the planet was depicted That they had not been observed in previous years was then conclusively ascertained by examination of the records of those years The record of canals seen here is registered after each opposition in a fresh map of the planet's surface This has been done since the beginning of the critical study of Mars at this observatory in 1894 Now when these maps came to be scrutinized for the canals each of them failed to show any such features Nor had any observer previous to 1894 recorded them as the observatory library of the subject bore witness Schiaparelli had never seen them nor had his predecessors or successors This determined definitely that no human eye had ever looked upon them before But stirring as it is to know that one is the first to see a new geographical feature on another planet akin to the thrill of finding unknown land in our own Antarctic regions a much deeper scientific interest attaches to the question whether a phenomenon previously undiscovered was also previously non existent For in that case one has seen something come into being with all that such origination implies

It might seem to persons not versed in the subject that its absence on the charts was proof that a canal was itself new in the second sense because it was so in the first but study of Mars has shown that this cannot be taken off hand for granted Several points must each be carefully considered In the first place one must be sure that the phenomenon could have been seen before yet was not It must be of a size which could not have escaped detection previously Now the great majority of canals discovered here were beyond the hope of detection elsewhere owing to the character of the air the improvement in instrumental means and the long acquired knowledge of the observers That they were not seen by Schiaparelli therefore by no means implies that they did not exist in his day— or even in the earlier days of observation here We see to day vastly more than we did in 1894 because of the experience acquired since In the present case however this possibility of error was excluded by the size of the canals in question They were not difficult detail of the order here mentioned but as I have said the most conspicuous on the disk canals which no observer of any standing whatever in good air could possibly pass by They would strike any skilled observer of such matters the moment he looked at the planet So far as this point went then they could not have existed before

The next point to be considered was whether they were results of a characteristic of the planet of vital import in its areography the annual seasonal change which affects all its features For the world of Mars is as subject to recurrent seasonal change as our own and more markedly so This change stamps itself unmistakably upon all its features obliterating some and bringing into prominence others according to the time of the Martian year Examples of this occur in the study of Mars regularly at each opposition the aspect of the disk varying according to a definite law dependent on the Martian season To be sure therefore that a canal is itself new the planet must have been previously carefully depicted at the same season of its year and then when these earlier drawings are critically scanned the canal in question not found recorded on them Now the possibility of definite and conclusive intercomparison of the sort is not presented so frequently as one might think Mars comes to opposition each time later and later by about two and a quarter of our own months This means that we meet him in a different part of his orbit at each fresh approach and so at a different season of his year Now until Schiaparelli's time it was at or near opposition only that his face was studied Schiaparelli extended the time greatly but not until the subject was taken up at Flagstaff was the period of observation prolonged to six and eight months for each opposition epoch thus enabling the same Martian season to be recurrently viewed by the seasonal overlapping of two or more observation periods

But even so the disk is not equally well presented in successive Martian years because of the differing distances the two bodies are apart and the difficulty of consequent comparison on the score of size Still another difficulty in the way of parallelism is that of phase Unless the two bodies be exactly opposite at the same season of the Martian year in the two cases, Mars will show a differing phase at each and this means a different slant in the illumination This is a very important distinction because the disk shows very diversely when illuminated from above or from the side so diversely that faintness of detail has often been attributed to intrinsic weakness of feature when illumination itself was the cause

In consequence the observer can never be quite sure that his data are comparable until he has himself seen the Martian disk under like conditions or nearly such which recurrent presentations demand a lapse of fifteen to seventeen years

Furthermore to be conclusive the observations must all have been made by the same observer, working under like conditions, and grown, in consequence familiar with every detail of the disk, since the personal equation including by that term the site and the instrumental methods and equipment, is always a factor A Martian cycle, that is, a round of about sixteen years must have been gone through by the same observer before definite judgment can be pronounced Such a cycle now stands complete at Flagstaff

Examining the records we find that Mars was observed four times previously at the same season of the Martian year as occurred during the epoch of the appearance of these two canals The canals were seen at this opposition as follows

	1909			In Martian Relative Chronology Northern Hemisphere	Heliocentric Longitude of Planet		Opposition
First appearance	Sept	30	2 [illegible]	Jan 6	1	50	Sept 23 1909
Last Observed	Dec	12	[illegible]	Feb 1	4	43	

The previous occasions on which the canals should have been visible if their appearance or non appearance were a consequence of the Martian season were

		Martian Dates	Opposition
1894 September 8	2	January [illegible]	October 20 1894
to November 18	[illegible]	February 1	
1896 July [illegible]	[illegible]	January [illegible]	December 10 1896
to August 28	[illegible]	February 1	
1898 July 1	296	February 9	January 18 1899
to August 28	[illegible]	February 1	
1907 November 1	78	January [illegible]	July [illegible] 1907
to January 2	[illegible]	February 1	

During all these periods the planet was kept under observation at Flagstaff and during none of them were any such canals recorded We are therefore sure that seasonal change cannot explain them and that two years ago and also eleven thirteen and fifteen years ago no such canals existed In Martian chronology this means that not only did they not exist in their present state during the previous Martian year but also not four five and six Martian years before that It is also fairly sure that they were not in existence thirty and thirty two years ago inasmuch as Schiaparelli never saw them

Lastly a further point disclosed by the Flagstaff observations must be reckoned with a point of very singular significance It was long ago discovered there that (see Bulletin No 8 of the Lowell Observatory) while the great majority of the canals are quickened into conspicuousness alternately every six Martian months first from the south and then from the north polar cap certain ones respond only to one or the other cap remaining inert to the action of its antipodal fellow To be sure therefore that the new canals were really new to Mars the old drawings had to be examined on this score too Here again the records were decisive No such canals had ever appeared before from the quickening of either cap at the time when had they existed then, they should have showed

The canals in question therefore, proved to be, not simply new canals to us but new canals to Mars In the canal system they are *novae* in fact or function, and as such are the most important contribution to our knowledge of the planet of recent years For let us see what they imply In form they are like all the other canals narrow, regular lines of even width throughout, running with geometric precision from definite points to another point when an oasis is located This oasis resembles all the other oases, a small round dark spot They partake, therefore, of all the peculiar features of the canal system features which I have elsewhere shown make it impossible of natural creation, that is of being the result of any purely physical forces of which we have cognizance On the other hand, the system exactly resembles what life there would evolve under the conditions we know to exist The present phenomena, then, show that the canals are still in process of creation that we have actually seen some formed under our very eyes

Thus, on every point which had to be considered, the records furnished conclusive evidence that the canals in question could not have existed in past Martian years in the condition in which we observe them to-day Their previous non-visibility could not have been due to any of the causes which might possibly affect it to-wit (1) Want of size (2) any personal equation of the observer (3) improved instrumental or atmospheric means (4) distance (all these are negatived by their striking conspicuousness) (5) phase, (6) regular seasonal change and last (7) unihemispheric seasonal change

---

* Nature

It will be perceived that the proof that these canals are *novae* has been possible and only possible through the long systematic work done on the planet here for the last fifteen years Without such a complete system of records the certainty that the canals in question were new canals to Mars could not have been reached

Lowell Observatory Flagstaff A I

POLONIUM.

SOME NEWLY DISCOVERED PROPERTIES.

BY MDME. P CURIE AND A. DEBIERNE.

It is known that among the new and strongly radio active bodies polonium was the first to be discovered Many efforts have been made already to isolate this substance and to characterize it as a chemical element but in spite of the great activity of the product obtained this result has not yet been achieved According to the theory of radio active transformations the quantity* of polonium present in radio active minerals must be very small According to this theory polonium is looked upon as a descendant of radium and the relative proportion of these substances in radio active equilibriums is equal to the ratio of their mean lives The mean life of radium being about 5 300 times greater than that of polonium and radium being found in pitchblende in about the proportion of 0 2 gramme per ton it is seen that the same mineral cannot contain more than about 0 04 milligramme of polonium per ton Many problems of supreme importance in radio activity are connected with the isolation of polonium This body is an unstable element which apparently represents the last radio active term in the series derived from radium we may therefore hope to show the formation of an inactive element derived from polonium Moreover polonium giving rise to an emission of α rays should produce helium and this production not yet having been observed it is important to ascertain if there really is in this a fact incompatible with theory

We have undertaken recently a chemical research with a view of preparing polonium in a concentrated state This was performed on several tons of residues from the uranium mineral which were at our disposal for this purpose The mineral was treated with warm strong hydrochloric acid which has the effect of dissolving polonium almost completely The solution which contains no radium was submitted in a factory to operations having for their object the extraction of its active matter This treatment which was done under our direction and which will be described in a more extended memoir furnished about 200 grammes of about a substance having a mean activity about 3 700 times that of uranium and which contained chiefly copper bismuth uranium lead and arsenic its activity was due to polonium We sought to purify this material by treatment in our laboratory

For this purpose the hydrochloric solution was precipitated with ammonia to remove copper and the precipitated hydrates were boiled in a solution of soda to dissolve the lead they were mixed next with a warm solution of ammonium carbonate to dissolve the uranium All these operations were repeated several times The insoluble carbonates finally obtained were dissolved in hydrochloric acid and the solution was precipitated with stannous chloride These operation together were very successful the original activity being found in the final precipitate in a sufficiently complete manner, which we verified by appropriate weighings

The precipitate which weighed about 1 gramme was redissolved and the hydrochloric solution was precipitated by sulphureted hydrogen The sulphides were washed with sodium sulphide then redissolved and the solution was reprecipitated with stannous chloride, the resulting precipitate weighed a few milligrammes Spectrum analysis effected on this material showed the presence of a diversity of elements— mercury silver, tin gold palladium rhodium platinum, lead zinc barium calcium and aluminium some of these elements being derived from the vessels employed On attempting to purify the active matter we encountered great difficulties and we found it very difficult to obtain without loss a substance of a more simple composition Thus on trying to separate lead by treatment with potash we found that a large part of the polonium passed into solution although we were able to utilize without danger the same reaction in the presence of elements insoluble under these conditions From this alkaline solution polonium can only be reprecipitated by the addition of an alkaline sulphide. The reactions which we always found to be trustworthy are· Precipitation as sulphide from an acid or alkaline solution; and precipitation with stannous chloride We also have found that polonium is easily deposited by electrolysis, and this method may be utilized for a quantitative separation when we wish to extract polonium from an acid solution but at the same time other metals such as gold platinum mercury etc are deposited After many experiments the activity was concentrated in about 2 milligrammes of matter

The activity was measured by an electric method For this purpose a known and very small portion of the solution was evaporated on a thin plate of glass and the absolute value of the saturation current obtained with this plate was measured in an appropriate apparatus Knowing the value of the charge of a gaseous ion (4 7 × 10 E S units) and the number of ions produced by an α particle of polonium along its complete path (about 1 6 × 10^5) we can calculate the number of α particles emitted per second Knowing moreover the speed of decay of polonium (a reduction to one half in 140 days) and the number of molecules contained in a molecule gramme (about 6 × 10^{23}) we can calculate the amount of polonium present its atomic weight being supposed to be near 200 We also can calculate the amount of helium which is formed in a given time assuming that each α particle is an atom of helium

In this way we found that the quantity of polonium obtained would be about 0 1 milligramme this quantity is what ought to be found according to theory in 2 tons of good pitchblende Our active matter therefore might contain several per cents of polonium so that spectrum analysis might be attempted with some chance of success Many spark spectra were obtained and photographed unfortunately each of these operations involved a considerable loss of material

The appearance of the spectrum is complicated many elements being present gold platinum mercury palladium rhodium and iridium Some spectra also showed the presence of alkaline earthy metals which came probably from the attack of the vessels employed these were removed by electrolysis After a careful examination of the different spectra and the identification as complete as possible of known lines by their wave lengths (records of Exner and Haschek Watts) or by comparison spectra obtained with the same spectrograph some lines were left which might be attributed reasonably to polonium The wave lengths of these lines are

Weak	4 642 0
Rather strong	4 170 5
Weak	3 913 6
Very weak	3 672 1
The following lines are of doubtful origin	
Medium may be a parasitic line	4 651 5
Medium may be identical with the aluminium line 3 961 7	3 961 5
Weak may be identical with the platinum line 3 668 6	3 668 5

The accuracy of these measurements is pretty good the error probably not exceeding 0 3 Angstrom unit For the identification of the lines we not only considered the wave length but also the relative intensity

We hope to examine the spectrum again when the polonium has disappeared- this will allow us to form a definite opinion on the attribution of the lines indicated above We also may hope to see the spectrum of the element formed at the expense of polonium According to theory this element should be lead lead is not entirely absent from our product but its spectrum is very faint

We have observed that the active substance obtained does not give rise to induced radio activity nor to any appreciable emission of penetrating rays We have observed also an extremely minute disengagement of radium emanation

A portion of the solution was utilized for the study of the gas disengaged The solution was introduced into a quartz tube which itself was placed in an apparatus which could be completely freed from air The solution disengages much gas, it is easy to observe the continuous formation of gas bubbles proving the decomposition of water, this decomposition must be attributed to the action of the α rays of polonium The gases disengaged are almost totally absorbed by the action of heated copper and oxide of copper of potash and phosphoric anhydride The slight gaseous residue was collected and examined by one of us by the method formerly used for the examination of the gases disengaged by actinium and radium (Debierne Comptes Rendus [illegible] 1909) This residue is sensibly pure helium its complete spectrum was observed and the volume measured The volume was equal to 1 3 cubic millimeter at atmospheric pressure the accumulation having been going on for 100 days This volume is very near that predicted by theory which is 1 6 cubic millimeter The fact of the production of helium from polonium is therefore established with the predicted order of magnitude We propose to make as accurate as possible a determination of this volume together with experiments on the numeration of the α particles emitted so as to obtain the value of the number of molecules contained in a molecule gramme This direct method seems particularly advantageous when using a solution of polonium as in that case the α particles are completely absorbed by the liquid

In the course of our experiments a curious effect of the rays was observed The polonium was kept dry in a small quartz capsule This capsule was found to be cracked in a large number of places under the substance The production of these cracks may be attributed to electric discharges

An abundant disengagement of ozone was noticed generally in the neighborhood of the substance — Comptes Rendus cl pp 386 389 February 14th 1910

A NEW APPLICATION OF ALTERNATING CURRENTS OF HIGH TENSION

The Textile World Record describes a new process for removing the electrical charge which textile fibers and fabrics acquire in the operations of spinning and weaving It is a well known fact that wool silk and other textiles under the influence of pressure and friction acquire an electric charge which they retain persistently In wool working establishments this electrification of the material causes several grave inconveniences In spinning the strands having electrical charges of the same design repel each other so that instead of lying parallel in the yarn they protrude in loops The electrification also causes adjacent strands to become entangled and torn The individual fibers of the strands exhibit similar peculiarities Instead of lying smoothly they separate widely and give the yarn a rough and irregular character The electricity developed in shearing the cloth is another source of annoyance The clippings and dust acquire an electric charge opposite to that of the cloth and consequently adhere to it These troubles are most marked on bright winter mornings when the dryness of the air favors the retention of the charge The only remedy that has hitherto been found at all effective is the production of moist and hot air in the factory The use of this expedient produces an almost insufferable temperature and the result has become more and more unsatisfactory with the steady increase in the velocity of the machines

Chapman an American inventor has devised an entirely new method of obviating all of these difficulties The most important part of his apparatus is a steel tube about 1½ inch in diameter which is slit longitudinally and incloses a well insulated cable which is traversed by an alternating electric current The slit in the tube is filled by insulating porcelain buttons almost in contact with each other The electric current ionizes the air around the tube to a distance of several inches and the magnetic forces developed by the alternating current causes a continuous and rapid motion of positive and negative ions in directions at right angles to the tube In the course of this movement the fabrics come into contact with oppositely charged ions and thus lose their charge while the ions which carry charges similar to that of the fabric are repelled As an alternating current is used both positive and negative charges are dissipated in this way The process has already been used in America It possesses an especial advantage from the hygienic point of view, as it not only avoids the heating and moistening of the air but it actually disinfects the air by the production of ozone — Umschau

ENGINEERING NOTES.

Contrary to a widespread belief that hard woods give more heat in burning than soft varieties the scientists at Washington are contending that the greatest heating power is possessed by the wood of the linden tree which is very soft Fir stands next to linden and almost equal to it Then comes pine hardly inferior to fir and linden while hard oak possesses 8 per cent less heating capacity than linden and red beech 10 per cent less Domestic Engineering

A novel method of catching fish was described in a recent issue of the Electrical Review and Western Electrician A trolley line running between Franklin and Columbus Ind skirts the White River for a considerable distance and it has been discovered that the trolley wire is frequently tapped to furnish current for fishing by electricity An end of the wire is placed in the water and the current stuns such fishes as come within its influence so that they can be taken out with scoop nets

Experiments made last year on the Swedish railways in regard to the possibility of employing peat as a fuel for locomotives of various types have not given the results which were hoped for On the contrary they show that the locomotives now in use are not suitable for the employment of peat unless this is mixed with a large proportion of other fuel In consequence of these results the engineers of the Swedish government railways are engaged in designing locomotives better adapted for the combustion of peat and with these locomotives the experiments will be continued

In a paper read before the American Society for Testing Materials Robert Job describes a simple test of the value of lubricating oils under service conditions He found that when heated to a temperature of 450 deg F the oils which had given bad results showed a very marked darkening of color while those which had proved satisfactory showed very little change Another experimenter F Camerman of the Belgian State Railway has devised a test of oils for lubricating engine cylinders By heating the oil to 400 deg F for six hours it is possible to determine the percentage of oil available for lubrication after allowing for that which escapes with the steam This varies from a very low figure to as much as 60 per cent

The distinguished gas engineer A Witz states in [illegible] Revue [illegible] field for the application [illegible] extend [illegible] importance of using directly in the gas producer the hot exhaust gases from gas engines worked with suction producers A column of coke could be maintained at a temperature of incandescence with little loss of the fuel and the CO and H O vapor would be decomposed by means of the sensible heat brought in by them It would be necessary to add a little oxygen to the charge in the engine cylinder but the nitrogen and CO undecomposed would supply the quantity of diluent necessary to temper the force of explosion Any back pressure on the engine due to resistance of the coke column in the producer throttling the exhaust could be regulated by a valve in the exhaust pipe

In a paper read before the Association Technique Maritime A Rateau describes some experiments which shed some light upon Lanchester's conclusion that the surface friction of a plate is 0 02 times as great as the pressure on the plate would be were it placed normal to the air current whereas Zahm's and other experiments on surface friction show that the coefficient is about one tenth of the above value A partial reconciliation of the two views is afforded by Rateau's discovery that the resultant pressure is in general not normal to the plane the variation differing with the angle of inclination For planes inclined at 10 deg to the air current the deviation of the resultant from the normal is 1 deg which would correspond to a coefficient of 0 0017 instead of the 0 02 adopted by Lanchester Rateau's treatment of this fictitious friction is based upon his theory of the screw propeller

In an article published in Lumière Electrique P André describes the construction and trials of a new turbine introduced by A Barbezat and constructed in the Bollinckx Works The principle of construction is that of a combination of a De Laval wheel and a Parsons reaction rotor on the same shaft the drum of the reaction portion being made conical in section, as suiting better than a horizontal cylinder form the escape of the steam from stage to stage with minimum loss of speed or amount of friction A single balancing piston can also be used and this is provided by the large end of the conical drum itself The idea in this turbine is to unite the advantages of the De Laval turbine for high pressure steam (with a reduced peripheral velocity of the wheel) and the reaction principle of Parsons turbine for the lower pressures, this being considered the most efficient portion of the Parsons machine The trials show fairly good results and it is expected that some improvements will be carried out in subsequent machines

SCIENCE NOTES

Scandium is one of the metals of the rare earths which occur in certain minerals It appears to be pretty widely distributed for Sir William Crookes in his spectroscopic examination of 53 minerals found scandium in 10 minerals anerlite cerite keilhanite mosandrite orangite orthite pyrochlore, thorianite thorite and wiikite The last named mineral is the only one which contains much more than 1 100 per cent of scandium The proportion of scandium contained in wiikite is 1 17 per cent Wiikite is an amorphous black substance about 5 times as heavy as water It is not completely dissolved by strong mineral acids but is readily decomposed by fusion with potassium bisulphite Heated to redness in a quartz tube it evolves water vapor hydrogen carbon dioxide helium and a trace of neon

How big is a meteor? W H Pickering estimates that a meteor of the third magnitude must vary from six or seven inches in diameter to a mere grain according as its brilliancy is similar to that of an electric arc or immeasurably greater That view is combated by C Fabri in the Astrophysical Journal From actual measurement Fabri finds that a star of zero magnitude gives an illumination of about 2 1 × 10 [illegible] candle meters when the star is at the zenith and the observer at sea level under good atmospheric conditions This would mean that a meteor of third magnitude 150 kilometers from the observer should have a luminous intensity of 3 000 candles or allowing for atmospheric absorption say 4 500 candles The crater of an electric arc gives about 200 candles per cubic millimeter Such a meteor would have a diameter of about 25 millimeters and if of density 4 would weigh about 1/3 gramme or 4 5 grains

Is there any meteorological evidence of a change in the rotation of the earth's axis? F von Kerner thinks that there is and presents his views in the Meteorolog Zeitschr He publishes a table which gives for the whole year and also for January and July the difference in mean temperature between successive belts of 10 deg latitude of the northern hemisphere For comparison the greatest and least difference occurring between each pair of belts are also given The variations of the differences actually occurring along a belt are found to be commensurate with the changes which may be assumed to be due to a shift of the pole and hence we must be very cautious in drawing conclusions as to the probability of a shift of the pole from meteorological evidence Thus in January for the belt 60 to 70 deg the mean difference of temperature between its northern and southern limits is 95 deg C but in longitude 145 deg W (Alaska) it is as much as [illegible] deg If we suppose a winter flora on the south coast of Alaska (lat 60 deg) becomes fossilized and a shift of the pole through 10 deg occurs along the 145th meridian and if further the change be accompanied by a change in the configuration of land and sea such that the January temperature in lat 70 deg is unaltered we might find in lat 70 deg a fossil flora which would indicate a January temperature higher by 25 deg From the mean distribution of temperature along this belt we might conclude that a shift toward the pole through 27 deg of latitude had taken place whereas the actual shift has been assumed to be only 10 deg Similar arguments are brought forward for other parts of the world

What is known as a white rainbow is an extremely rare phenomenon It was observed at the Montsouris Observatory at Paris by M Louis Besson on the 5th of February It was an almost colorless bow and was seen at 2 10 P M dying out and then reappearing at 3 15 reaching a maximum brightness at 3 25 then disappearing five minutes later The bow had about 3 degrees width and was not a pure white, but somewhat tinged with rose color at the outer edge and violet at the inner edge At its brightest it had an interior darkish band of somewhat violet hue The angular height of the summit was 40 deg 8 min on the average There have been often observed in the mountains or the polar regions white bows upon fogs or clouds composed of liquid drops The explanation of this phenomenon known as the "Ulloa circle" was given by Mascart It is only a special case of the general theory of the rainbow as given by Airy which allows of supposing a mixture of the colors so as to approach white at the same time as a widening of the arc and a diminution of the radius when the diameter of the drops becomes smaller and comes near to 41 µ But the present phenomenon appears under very different conditions from what accompany the Ulloa circle The heavens were covered with an elevated cloud layer with small density (alto-stratus) and owing to the general conditions of the sky and the great height of the clouds we are led to suppose that the elements of the clouds which produce the rainbow are rather of an icy than a liquid nature The author states that he knows of but a single case of an analogous phenomenon which was seen in England on February 2nd, 1908, also in clear weather and with about the same kind of clouds.

TRADE NOTES AND FORMULÆ.

Wood Preservative Paint.—300 parts of well washed and sifted white sand, 40 parts of copper oxide, 1 part of sulphuric acid The four first named ingredients to be melted and mixed and then the copper oxide and sulphuric acid added

Waterproof Paint for Wood—The wood is painted with zinc white rubbed down in glue water (size) several hours later apply a coating of very dilute chloride of zinc The resultant combination (zinc oxychloride) protects the wood from growths of mold thickness and moss

Badigeon is a paint mixed with slaked lime and stone dust or other resembling stone mortar Italian badigeon also known as normillo is a finish made from lime Spanish white and a color addition applied in layers and rubbed with hard brushes or woolen rags until it acquires a polish

Fireproof Paint—35 parts zinc white, 15 parts air slaked lime 25 parts white lead 5 parts sulphate of zinc Mix the first two ingredients and grind them adding oil then add 4½ parts of water glass (35 per cent) next the white lead and sulphate zinc stirring all well together This makes a white paint If other colors are desired any coloring substance can be added

Antacid Varnish for Leather Gall nuts 200 parts logwood 30 parts water 200 parts is boiled for two hours the water evaporated to be replaced from time to time and filtered Dissolve in the filtrate 40 parts of green vitriol 200 parts of brown syrup boil the fluid again until it begins to thicken then add a solution of 10 parts of ruby shellac in 30 parts of strong alcohol Must be kept in tightly closed bottles

Asphalt Cement for Leather Belts—Asphalt 12 parts rosin 10 parts gutta percha 40 parts sulphide of carbon 150 parts petroleum 60 parts The materials without the sulphide of carbon are first treated in a bottle standing in boiling water with the petroleum the thick mass is allowed to cool add the sulphide of carbon and allow the whole frequently shaking it to stand several days The belts evenly coated with the cement should be exposed to heavy pressure between hot rolls

Asphalt Lubricant for Wagon Wheels—Asphalt 30 parts black pitch 8 parts litharge 8 parts water 80 parts petroleum 8 to 12 parts The asphalt is melted in a kettle equipped with a stirring apparatus then the pitch and the litharge stirred in 8 parts of petroleum being at the same time added, Finally the water is added in small quantities the remaining 4 parts of petroleum being used if added to make the lubricant thinner For use in winter it is made thinner than in summer

Finish for Leather.—a 125 parts of brown shellac to be dissolved in boiling solution of 26 parts of borax and 3 parts of caustic soda the powdered shellac being previously moistened with some ammonia b 56 parts of log wood extract solution of 30 deg Bé (approximately 400 parts of extract to 1 000 parts water) 10 parts glycerine 10 to 20 parts of aniline black and bethylene blue dissolved in 300 parts of water mixed with the shellac solution Add a mixture of 50 parts pyrolignite of iron of 20 deg Bé and 90 parts of water and add oil of mirane and thymol

Sulphur Chips for Sulphuring Casks—Melt stick sulphur in an enamelled iron vessel heat it to 312 deg to 362 deg F and draw through the molten sulphur pieces of unsized fine writing paper 10 inches long and ¾ of an inch wide The strips of paper coated with sulphur (sulphur chips) are suspended alight on a wire hook inside the bung hole in the cask to be sulphured and allowed to burn there Continue burning the sulphur chips in the cask as long as they will burn, and then bring up the cask Before it is filled again it must be washed out with water several times

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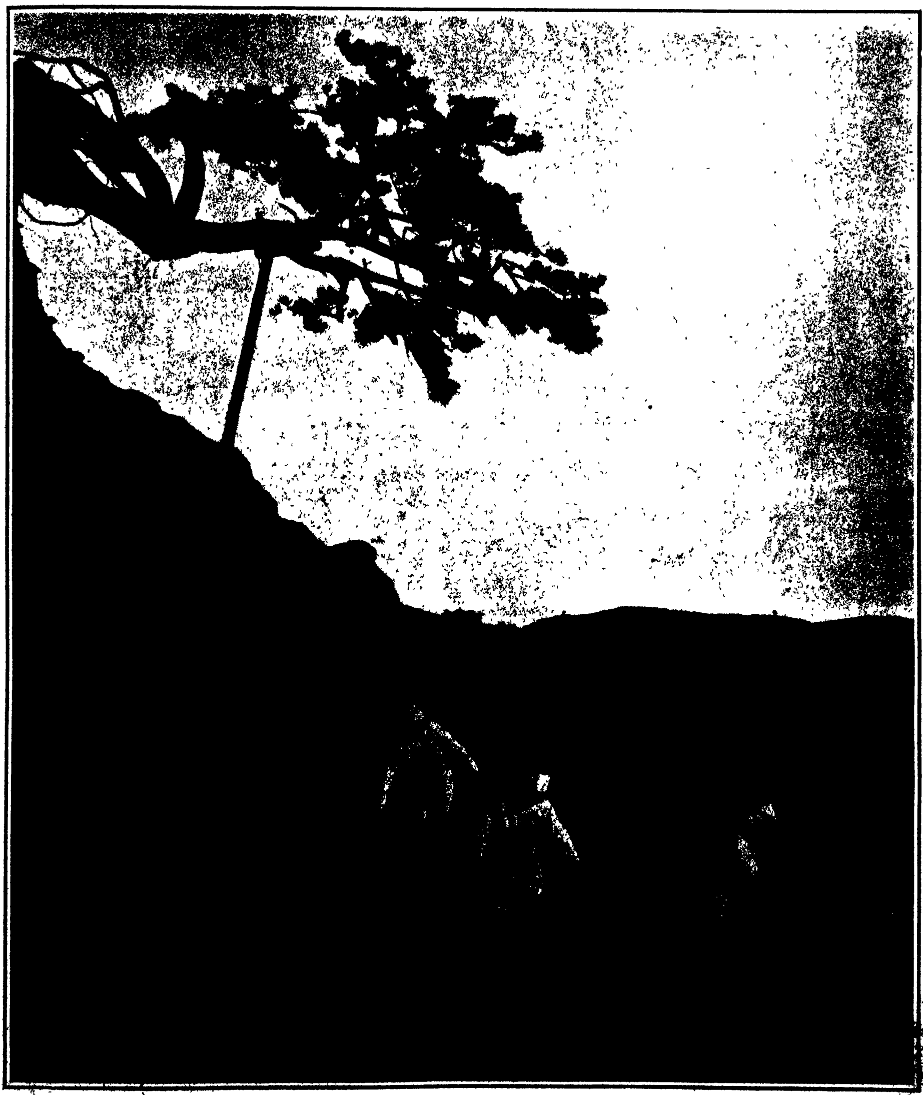

THE WOMEN PEARL DIVERS OF JAPAN.—[See page 200.]

THE ARTIFICIAL SILK INDUSTRY.—III.*

CONVERTING WOOD INTO SILKEN FABRIC.

BY W. P. DREAPER, F.I.C.

Concluded from Supplement No 1785, Page 181

PROPERTIES OF THE FIBERS

Recognition of artificial silk yarns.—The nearer these yarns approach real silk in their physical properties the more important will it become to have a satisfactory method for distinguishing between them. The qualitative and quantitative estimation of these different fibers has been studied by Saget and Suvern (Bull Soc d Encouragement 1906 40) in comparison with real silk.

The ash in these products is under per cent. Natural silk contains 1 per cent of nitrogen as compared with the following figures for artificial silk:

Nature of Yarn	Per cent
Pauly make (Cuprammonium)	13
Chardonnet (Nitrocellulose) French	1
Chardonnet (Nitrocellulose) German	16
Lehner (Nitrocellulose)	07
Nitrocellulose	11 to 13 1

It must therefore be the different state rather than the amount in which the nitrogen is present in the (reduced) nitrocellulose products which determines its effect in dyeing with basic dyes if this is the real cause of this phenomenon.

Diphenylamine sulphate is the ready test for artificial silk and gives the following reactions:

Silk	Brown coloration
Tussah silk	Brown (intense)
Chardonnet & Lehner (Nitrocellulose)	Intense blue
Pauly Viscose or Yarmouth silks	No reaction

Strength on wetting. This loss in strength has introduced a serious factor into the manufacture of textiles but under present conditions this defect is gradually decreasing and may in time be eliminated. This is seen by comparing figures published in 1900-1901 with more recent figures which are available.

In the year 1900 an isolated test (Bronnert Bull Soc Ind Mulhouse 1900) gave a loss of 77 per cent for Chardonnet silk in strength on wetting.

In the year 1901 Strehlenert gave the following figures:

Yarn	Dry strength	Wet strength	Loss per cent
China silk	53 2	45 7	14 1
French (crue)	50 4	40 9	18 8
Chardonnet silk	14 7	1 7	88 5
Lehner	17 1	4 3	74 8
Viscose (old)	11 4	3 5	70 0
Viscose (new)	21 5	3 5	84 0
Glanzstoff	19 1	3 2	83 0

These figures give an average loss of 8 8 per cent on wetting for the artificial products.

In 1903 Hassack gave the figures from which the strength per denier has been calculated as follows:

Quality	Denier	Breaking strain in grms	Do per denier in grms	Elasticity per cent
Genuine silk	23	57 5	2 5	21 6
Chardonnet silk*	80	74 2	0 93	8 0
Fismes*	100	71 7	0 71	11 6
Walston*	120	151 4	1 26	7 9
Lehner*	120	171 8	1 43	7 5
Pauly	120	197 [illegible]	1 64	12 5
Gelatine	100	63 0	0 63	3 8

* Nitrocellulose products

Recent figures given by the testing department of the Manchester Chamber of Commerce show the following results:

Yarn	Dry strength	Wet strength	Loss per cent
Glanzstoff	92 5	31	66
Cellulo silk	75	33	56

According to these figures the Glanzstoff product now loses 17 per cent less on wetting than in 1901. The cellulo silk product loses still less. The present day strength (dry) is given by Cross and Bevan at 1 0- 1 4 grammes per denier against 2 0- 2 5 grammes for real silk. I think this figure should now be extended to 1 6 grammes for the artificial silk product. The extensibility under breaking strain at 13 per cent to 17 per cent for the artificial product against 15 25 per cent for real silk. The average loss in strength on wetting is given at 70 per cent for all varieties (Escalier).

I have recently received a sample of a 25 denier artificial thread containing 66 filaments which has a breaking strain of 58 5 grammes. This shows a breaking strain of 2 3 grammes per denier. This is quite as strong as some natural silks. A pound of this silk would contain 175 000 yards which would contain 10 000 000 yards of filaments or six times the length which a corresponding weight of natural silk of the same size would contain.

Dyeing properties.—No two makes of artificial silk dye in exactly the same way. All the makes on the market dye with the direct or cotton dyes as might be expected. The general procedure is to dye at a low temperature but I have seen artificial silk in mixtures dyed at the ordinary temperature for silk after a boiling off in 1 per cent soap solution for 1½ hours. Ingrain colors do not seem to give fast results on this product the reason for this is unknown. Difficulties have been experienced in dyeing some dark shades satisfactorily in the past but these have been overcome.

The cellulose acetate product stands alone in its dyeing properties. It is stated that a dye-bath containing alcohol greatly facilitates this operation.

The nitro product is not capable of standing the Lancashire bleach but samples of cellulo silk have stood it fairly well. Real silk would go into solution under the treatment.

Waterproofing.—The lack of strength in the finished yarn in the wet state has as mentioned been a source of great complaint in the past. Great improvements have taken place in this respect and there are indications that with time this defect may be altogether overcome. Naturally all manufacturers have been engaged in the problem of preventing this degradation of the fiber when wet due to the hydration of the reprecipitated cellulose. No known process of waterproofing by the application of waterproof materials in a suitable solvent is applicable or of any real value. An attempt on altogether different lines has been made by Escalier (Monit Scient 1908 13 and patents) who claims that he brings about a condensation of the cellulose molecule by treatment with formaldehyde. The recently published results of the strength of yarn in the dry and wet state certainly indicate a specific action and that this treatment reduces the tendency for the thread substance to return to the jelly state in the presence of water.

Some years ago the application of formaldehyde for this purpose was patented by Strehlenert (Eng Pat [illegible] 10 of 1896) but it was only claimed for nitrocellulose products and was applied to the solution of that substance before squirting.

The only alternative to some such process seems under present conditions to be the use of a raw material which will not hydrate in the presence of water. This material is undoubtedly present in acetyl cellulose and if the working of this material becomes amenable to commercial conditions any special treatment will be unnecessary. However cellulose acetate is so waterproof that it will not absorb dyes from aqueous solution. Silk itself has the advantage of not losing its strength in the wet state yet it is easily dyed.

The loss in strength on wetting is a temporary defect. It is entirely regained on drying. For example fabrics of artificial silk and silk in mixture were boiled in 1 per cent soap solution for 1½ hours in order to discharge the silk gum from the silk. They have suffered little if any deterioration from that process. Care is needed in the handling in the wet state but it is not beyond the scope of modern dyeing and finishing to meet the necessary conditions even with very fine counts.

Any further small reductions in the loss on wetting will materially decrease the difference which exists to-day between the relative strength of these yarns and silk and bring nearer the time when they may be equal in this and other respects.

Scroop.—The peculiar rustle which silk possesses when dried out of solution of acid is imitated when these artificial fibers are treated in the same manner so that in this respect the behavior of the two fibers is identical. This fact may on investigation give some more definite explanation as to the cause of this phenomenon.

The brilliancy of the fiber in the coarse counts is greater than that of real silk. In the processes dealing with the production of these yarns directly from cellulose the chief factor in obtaining this is the method of stretching the yarn during drying. The nitrocellulose product if properly denitrated is very brilliant owing to the surface condition of the fibers and as in other makes the continuous nature of the filaments.

Size of Individual Filaments.—The 120 denier thread of to-day varies in the number of the individual filaments but it may be said not to exceed 25 in number so that the size of the individual filament may be taken at from [illegible] to 8 denier. Actual silk averages 2 75 denier per filament. The fine denier cellulo silk (30 to 50 denier) may contain 45 to 60 filaments so that here the size is about 0 5 to 1 1 denier. The fineness of real silk has been exceeded in this case. In the sample produced of a 1 denier artificial silk thread (Yarmouth make) the individual filaments are 0 33 denier or roughly ¼ of the size of those of real silk. This is the first time that such a thread has been exhibited.

WORLD'S OUTPUT OF ARTIFICIAL SILK

This has been recently given at about 3 000 000 kilos per annum at the present rate of production against 1 700 000 kilos in 1906 and 600 000 kilos in 1896. These figures indicate an increase of 500 per cent in 13 years.

The nitrocellulose product still heads the list with an output of between 1 300 000 and 1 500 000 kilos. The copper ammonia process accounts for 1 100 000 to 1 300 000 kilos. The production of viscose silk now amounts to [illegible]00 000 kilos.

These figures are large but that will be greatly exceeded in the future. Within three years the viscose production may be doubled as it is the intention to establish large works in America and elsewhere.

Output of Natural Silk.—The total returns for 1908 of the 24 European conditioning houses amounted to 51 415 000 pounds. These figures show an increase of 30 per cent in a decade (the average for the years 1896 8 being 34 529 400 pounds) to which all the three great producing centers viz Europe the Levant and the Far East have contributed. It is however significant that the increase in Europe is only 20 per cent against [illegible]0 per cent for the Far East and 100 per cent for Asia Minor. This last increase is said to be entirely due to the efforts of the Silk Institute at Broussa and the consequent introduction of scientific methods. In France the production of cocoons has not increased during the last years in spite of large sums paid in State bounties amounting to over £150 000 a year.

In 1906 227 spinning mills spun 1 732 018 pounds of silk in France. A comparison of these figures with those of the present production of artificial silk which has also been given elsewhere at 5 000 tons per annum is instructive.

There is no indication that the large production of artificial silk is materially affecting the gradual and increasing production of the real article especially as the present production is practically confined to high denier sizes (100 and above). These have a use which may be stated generally to be specific to the artificial product. Exactly what influence the finer counts will have on the production of the real product is a matter which must be left to the future.

It is obvious that an enormous industry must spring up before any appreciable result is noticed in the direction of a restricted output of real silk. One can only speculate on the effect of such a revolution if the finer artificial silk is manufactured down to 15 denier and ultimately equals in strength the natural product. A rough opinion may be formed as to the future of the industry on the statement made in a report by the United States consul at Lyons that already 10 000 hands are employed in this industry. If this figure is correct—and it may not be very far from the mark—this industry will in the future give employment to a great number of hands and become an increasingly important branch of the textile industry.

It is interesting in passing to examine the position taken up by some authorities in this country that there is an advantage in letting other nations work out new processes and then establishing a position on the market with their early experience and failures before us. The manufacture of this material under the conditions reviewed starts here with a financial handicap for the leading Continental firms have already written down their works plant and rights to a nominal amount, out of the abnormal profits in the past, they have a trained staff and great experience at their disposal. So that this must be set against any security arising out of such an assured position. On the other hand, it is claimed that in the two processes working to-day in this country, at Coventry and Yarmouth respectively, the details of manufacture have been more successfully worked out here than on the Continent. The viscose process is working on a large scale at Coventry, and there are indications that the Yarmouth research works may lead to an equally important development in the production and marketing of finer counts The Flint works is not yet producing yarn

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* Paper read before the Society of Chemical Industry and published in its Journal

RELATIVE VALUE OF DIFFERENT MAKES TO ONE ANOTHER AND TO SILK

However interesting many of the products may be from the scientific standpoint after all their commercial value and adaptability are of first importance It is too early to attempt to define their relative values either from the point of view of cost or their respective physical or chemical properties

I would suggest with all reserve that up to the present time this so-called artificial silk has hardly come into direct competition with the natural product and that this has been an important factor in favor of its development in the past It has created and is creating uses for itself Its selling price bears little relation in its fluctuations to that of real silk but with the demand in excess of the supply this is not in itself conclusive evidence in this direction but it tends to confirm other known facts

With the material now being introduced in finer counts it may certainly enter into direct competition with silk The substitute must then chiefly claim advantage on the grounds of price value With an improvement in strength in both the dry and wet state competition must increase as it has done in the past between the natural and artificial indigo and alizarin products and be governed by the relative conditions of supply The last [illegible] years have seen a marked improvement in strength and so-called elasticity There is no evidence that the limit has been reached or even approached

There is also the question of the relative covering power of the yarns when woven The ordinary makes of artificial silk have only 60 per cent of the covering power of natural silk With an increase in the number of filaments in each thread a corresponding improvement in this respect naturally follows as in the cellulo silk product The limit to-day may be put at 60—75 per cent of that of real silk So that there is still room for improvement in this direction The density of the cellulose substance is about 10 per cent in excess of silk so that a covering power of 90 per cent may be regarded as the maximum under equal conditions

This is hardly the occasion to do more than point out the financial gain which has ultimately come to those who have carried this industry to its present state on the Continent Notices which occur in the textile journals from time to time indicate this in detail The leading companies have paid steady and increasing dividends up to [illegible] per cent or more (See Dreaper J Soc Dyers and Col 1907 p [illegible] and Dreaper and Davis *ibid* 1908 p [illegible])

The manufacture of yarns by a process entailing the solution of the raw material as a preliminary step has therefore become a reality It is evident that the future will see an extension of output due to the growing appreciation of the value of these yarns and the consequent extension of its use

RADIUM IN DISEASE.

AN INFANT BRANCH OF THERAPEUTICS.

ATTENTION has again been directed says Nature to the possibilities of radium as a curative agent by Sir William Ramsay and by Sir Lauder Brunton

The supply of radium available for the treatment of disease is still so limited that the therapeutic usefulness of this agent has not yet been fully determined No sooner were indications noted of a prospect of relieving cancer by the use of radium than all the radium obtainable was devoted to this purpose consequently its action in less serious ailments is still almost unknown

In the treatment of cancer radium has usually been employed in the form of crystals of the bromide These crystals are contained either in a sealed glass tube or in a button with a covering of thin glass aluminium or mica Recently the crystals have been spread in a thin layer upon a flat surface and covered with a layer of varnish Such buttons and spread preparations are suitable for application to the surface of the body The glass tubes may be inserted into the interior of tumors or into orifices of the body thus they may be placed in the mouth or nose in the œsophagus (within a rubber tube) in the rectum or in the cervix uteri

Of the three types of radiation given off by radium (the alpha beta and gamma radiations) the view commonly accepted is that the gamma rays have a selective action destroying cancer cells while leaving the normal cells of the part intact while the alpha and soft beta rays destroy all cells indiscriminately Means must accordingly be used to prevent the alpha and soft beta rays from reaching the body A filter consisting of one millimeter (.039 inch) thickness of lead is suitable

As it is risky to send a patient away with a valuable tube of radium crystals within his body sealed glass tubes of radium emanation have recently been used (Lancet December 11th 1909) They are inclosed in lead tubing one millimeter (.039 inch) in thickness These tubes of emanation do not differ from the crystals in the rays they emit or in their action there is however one important difference the radioactive strength of the emanation tube decays according to an exponential law in such a way that the strength is reduced to one-half at the end of about four days Such tubes of about 10 milligrammes (.154 grain) strength may be placed in contact with a cancerous growth (say in the rectum) and allowed to decay *in situ* At the end of a fortnight they may be removed as being then too weak to be of further use

Other methods have been tried in a few cases thus dilute solutions of radium bromide have been given by mouth and water in which radium emanation has been dissolved has been injected subcutaneously

Coming now to the results obtained the accounts are very conflicting Undoubted relief has been obtained in a considerable proportion of the cases cancerous tumors have diminished in size and have disappeared altogether in some cases But some of the earlier cases reported as cured have since been found to relapse; in some cases the growth has recurred in the original situation, while in others cancerous deposits have formed in internal organs It seems fairly certain that in some cases cancerous growths may be cured in their early stage by radium but it is not yet justifiable to attempt this unless the patient is so feeble (through heart disease or Bright's disease for instance) that the removal of the growth by operation could not be undertaken.

When the surgeon has declared a case inoperable radium (or Rontgen ray) treatment is used as a last resource and the attempt is usually a desperate one It is something then to be able to report the complete disappearance of malignant growths in some of these cases even though the final result is not a cure The local treatment of cancerous growths does nothing to prevent dissemination of the disease in the internal organs and it is with the idea of achieving this result that attempts have been made to cause radium or its emanation to circulate through the body In doing so it must be remembered that the alpha radiation is giving out its full energy in the body and since this radiation possesses about a hundred times as much energy as the beta and gamma radiations together it is clear that for practical purposes we may disregard the effect of the gamma radiation in this connection Now we started with the postulate that the alpha rays are indiscriminately destructive so that if enough is allowed to circulate in the body to destroy cancer cells the normal cells of the body will also be destroyed It must be allowed however that the observations upon which this postulate are founded are by no means conclusive and though there is no doubt that the alpha and soft beta rays destroy normal cells far more readily than is the case with the gamma rays it may still be true that they too possess some degree of selective action if the dosage be regulated with sufficient accuracy

This branch of therapeutics is still in its infancy and it would be a mistake either to raise delusive hopes because some cancerous growths have been made to disappear under its use or to declare it useless because disappointments are common One disease rodent ulcer is cured by the use of radium in the great majority of cases only a few rodent ulcers proving refractory to its use There are however other methods of curing rodent ulcer The further development of this branch of medical science will be watched with great interest

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THE FRENCH ANTARCTIC EXPEDITION

THE French expedition under Dr Jean Charcot on board the Pourquoi Pas? returned to Punta Arenas recently The early return of the expedition some weeks before it was expected is due to a series of misfortunes which limited the range of the expedition's operations

It will be remembered that this is the second of Dr Charcot's Antarctic voyages In 1903 05 on board the 'Français' he carried out an expedition along the west coast of Graham Land, south of Cape Horn wintering on Wandel Island in about 65° S lat and continuing the voyage to a point off Alexander I Land in about 68 S lat Apart from the additions made to cartographical knowledge of some of the islands off Graham Land the expedition was notable for the scientific observations and collections secured in the departments of hydrography terrestrial magnetism biology botany and geology

Dr Charcot's latest expedition was designed to extend the work done in 1903 05 The programme contemplated another cruise among the islands off the west coast of Graham Land whence it was hoped to continue the voyage westward in the direction of King Edward VII Land It was also proposed to make excursions southward to investigate the character of the supposed Antarctic continent and for this purpose the 'Pourquoi Pas?' carried a number of specially designed motor sledges The expedition was liberally subsidized (£21 000) by the French government and the ship a barquentine with an auxiliary engine of [illegible] h p was specially built for the voyage The French Naval Department the Paris Museum and the Prince of Monaco contributed to the scientific equipment and the scientific staff included besides Dr Charcot who belongs to the medical profession and is an experienced bacteriologist specialists in hydrography oceanography and meteorology tidal and chemical observations geology and glaciology natural history and terrestrial magnetism

The expedition sailed from Havre in August 1908 and from Punta Arenas in the following December Supplies of coal were taken on board at Deception Island (lat 63 S) in the South Shetlands which has become an important rendezvous for whalers On resuming the voyage the Pourquoi Pas ran aground and after being refloated lost her rudder in collision with icebergs The voyage however was continued to Adelaide Island south of the 67th parallel and the adjacent coasts were explored for a distance of 120 miles to Alexander I Land Being unable to find a safe anchorage the expedition then returned north and spent the Antarctic winter of last year off Petermann Island south of the [illegible] parallel Though attacked by scurvy and other diseases the explorers carried out several excursions and made a careful study of the glaciology of the region On the return of summer they continued their explorations among the South Shetlands again visiting Deception Island and also Bridgman Island (62 S) The course of the Pourquoi Pas? was then directed south and west and the expedition succeeded in reaching Peter I Island (lat 69 S long 90° W) Ultimately the voyage was extended between the 69th and 71st parallels to long 126 W King Edward VII Land extends between the 150th and 160th meridians of west longitude

Graham Land projects northward from the Antarctic Circle toward Cape Horn as a great tongue of land with numerous adjacent islands It has been visited by several expeditions but its connection with the Antarctic continent is still a matter of speculation Westward in the region south of the Pacific Ocean Cook and Bellinghausen sighted stray patches of land or appearances of land presumably part of the Antarctic continent but the continuous coast has never been definitely traced Geographically the value of Dr Charcot's expedition consists in the work he has been able to accomplish in linking up and defining more clearly the character of these stray patches of coast Exactly what have been the results of the expedition in this connection can only be determined when his charts become available As on the occasion of his former expedition the most valuable feature of the results will probably be the scientific data collected respecting the magnetic meteorological hydrographical and geological conditions in the regions south of Cape Horn Dr Charcot was unable to make use of his motor sledges for penetrating the Antarctic continent —Nature

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Since the beginning of the year two accidents have occurred to reinforced concrete reservoirs in Oklahoma which have attracted considerable attention from engineers in that part of the country These accidents the Engineering Record states were at Guthrie and Oklahoma City the two principal cities of the State In one case it is admitted that in an attempt to secure maximum economy too light sections were employed

CONSTRUCTING THE PARIS SUBWAY.

A DESCRIPTION OF THE FREEZING PROCESS EMPLOYED.

BY LUCIEN FOURNIER.

The line No 4 of the Metropolitan Railway of Paris, extending from the Porte de Clignancourt to the Porte d Orléans, which will shortly be opened to traffic, accomplishes the crossing of the Seine by means of very interesting and novel methods of construction In the section between the Rue des Halles and the Boulevard St Germain, it was necessary to sink caissons under the Seine, the Place St Michel, the Place St André, and the Flower Market, to construct steel tubes between these caissons and, finally, to join all these parts to form a continuous tunnel Of all this construction the part most difficult of execution was the section between the elliptical caisson of the Place St Michel and the caisson No. 5 beneath the Seine, passing under the street, the Orléans railway, the quay and part of the river bed The contractor decided to employ the freezing process, which has proved very successful in sinking mine shafts. Here, however, the conditions were different, for the freezing tubes could not be vertical, but were compelled to follow the axis of the tunnel, which, at this point has a grade of 4 per cent.

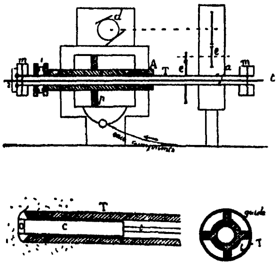


Fig 1 DIAGRAM AND DETAILS OF HORIZONTAL BORING MACHINE

The object of the process was to connect the two caissons by a tube of ice, 213 feet long, and to form, beneath the river, a huge block of ice which would prevent the entrance of water into this tube and the tunnel constructed inside it In order to make an absolutely watertight barrier it was necessary to place the freezing tubes so near each other that the cylinders of ice formed around them would meet and coalesce Hence 24 holes were bored parallel to the axis of the tunnel by two boring machines, which were mounted on pylons in the caisson of the Place St Michel These pylons supported platforms which could be moved both vertically and horizontally, so that the boring machines could follow the elliptical contour of the tunnel and could be brought to bear on any of the 24 holes.

The boring machines were designed especially for this unusual work Each machine (Fig 1) has a hollow shaft *A*, keyed to a hydraulic piston, *p*, by which the shaft can be advanced or retracted This shaft incloses a second hollow shaft, *T*, which in turn incloses a hollow boring rod, *t* The inner shaft, *T*, is rotated by an electric motor placed above the apparatus and can be rigidly connected with the outer shaft and the boring rod by means of a sleeve and mandrel While the boring rod is turned by the electric motor and driven forward by forcing water into the cylinder containing the piston *p*, a stream of water is forced through the boring rod by a small pump, for the purpose of cooling the boring tool and of washing the products of its action back through the space between the boring rod and the tube *T*

The boring tool *c* (Fig 1) is a stout iron tube, 10 feet long, terminated by a steel ring set with diamonds or other hard gems, which act like the teeth of a saw as the cutting ring is simultaneously rotated and pressed forward When the tool has advanced a certain distance, it is retracted into the tube *T*, and the latter which has a cutting edge in front, is driven forward without rotating, to the end of the boring. The boring tool is then moved forward and the boring is continued, additional sections of the tube *T*, which constitute the freezing tube, being inserted as the work advances

From this description it might be imagined that the boring of these holes is an easy matter, but the operation is far less simple in practice, especially when the mass to be traversed is not homogeneous. The lower part of the tunnel, to within a yard of the foot of the arch, passes through a mixture of marl and very hard limestone, containing flints, quartz, etc, while the upper part traverses a stratum of sand, mixed with gravel and flints This lack of homogeneity made the process very laborious, and the boring of each hole revealed unexpected difficulties which necessitated changes in the method of operation.

In each case the boring was commenced by inserting the end of the tube *T* into one of the 24 holes which had been drilled in the concrete of the elliptical caisson The velocity of rotation varied from 60 to 500 revolutions per minute, according to the character of the soil The borer advanced 20 inches in a continuous drive Six successive drives usually filled it with debris, so that it had to be removed from the hole and cleaned In some cases the injected water sufficed to keep the boring clear In working through the upper layer of sand and gravel a new difficulty was produced by pebbles wedging between the tool and the tube *T* This difficulty was overcome by substituting a boring tool which was so constructed that the debris washed away by the injected water remained inside the tool, but the progress made was so slow (5 or 6 feet per day) that an attempt was made to advance the tunnel at the same time This produced movements of the soft soil which destroyed the alignment of the borings and broke the tubes and boring rods In consequence of all these difficulties the tedious process of horizontal boring was abandoned in favor of the usual method, involving the construction of a working tunnel, protected by strong timbers The total length of the horizontal borings made was less than 300 yards, of which less than 70 yards were in gravel In short, the contractor's experiment was a failure.

The vertical boring under the Seine was much less difficult as the conditions were similar to those encountered in sinking mine shafts The holes were bored to a depth of 59 feet, or to about 3 feet below the bottom of the tunnel, in order to form a block of ice that would assure absolute protection against the infiltration of water from beneath, as well as from the sides The circulation of the forcing liquid in the tubes sunk in these holes is illustrated in Fig 2. The tube, closed at both ends, was traversed top to bottom by a smaller tube *Z*, connected with the outlet of the refrigerating apparatus The freezing liquid flowed down through the inner tube and up through the space between the two tubes as indicated by the arrows, and returned to the refrigerating apparatus through the tube *X*. The maximum distance between consecutive freezing tubes was equal to the radius of action of a single tube (about 5 feet) Here the cylinders of ice formed around the several tubes were completely united, forming a solid block of ice through which no water could pass.

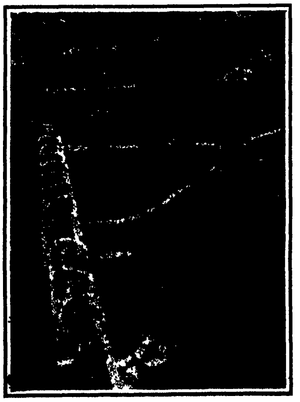


Fig. 4.—FREEZING TUBES UNDER THE PONT ST MICHEL.

The refrigerating apparatus installed at Place St. Michel, for the supply of the horizontal freezing tubes, was operated by two 100-horse-power gas engines, supplied by two generators of "poor gas.' The gas engines operated the ammonia compressor by mechanical transmission, and the electrically driven pumps by means of a dynamo of 220 volts and 350 amperes, which also furnished current for lighting The refrigerating machine (Fig 3) contains two cylinders, each of which draws anhydrous ammonia gas from a worm, immersed in a refrigerating tank, which contains a solution of calcium chloride The aspired gas is forced into the worm of a condenser, where it is liquefied by a current of cold water From the condenser the liquid ammonia flows to the worm of the refrigerating tank, where its evaporation, caused by the aspiration of the compressor, still further lowers the temperature of the calcium chloride solution. A rotary pump *P* draws this solution from the refrigerating tanks and forces it, at a pressure of two to three atmospheres, into the distributing mains, whence it flows through the buried freezing tubes and the return mains back to the refrigerating tanks A second pump, working at a pressure of 15 atmospheres, is employed, in alternation with the low pressure pump, in order to prevent the deposition of solid calcium chloride in the lowest parts of the circuit. The supply of condenser water (176 gallons per minute) was furnished by two rotary pumps installed on the bank of the Seine This refrigerating plant was capable of producing two tons of ice per hour The temperature of the calcium chloride solution varied from —4 to —13 deg. F. A smaller refrigerating apparatus, producing one ton of ice per hour and operated by an 80 horse-power electric motor, was installed on the quay for the supply of the vertical freezing tubes. As the larger plant, at Place St. Michel, was devoted to the same purpose, after the abandonment of the horizontal freezing system, it became necessary to establish a connection between it and the river. This connection was made by conduits suspended from the viaduct of the Orleans railway. These conduits were covered with a thick coating of frost.

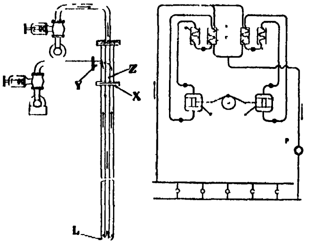


Fig. 2. Fig. 3

Fig. 2—CIRCULATION IN VERTICAL FREEZING TUBE Fig. 3- DIAGRAM OF REFRIGERATING APPARATUS

Unfortunately, it was impossible to sink freezing tubes beneath the Orleans railway or the quay, so that on each side of the tunnel, and especially on the up-stream side, there was a spot where the ice barrier was thinner than elsewhere. Moreover, the walls of the quay rested on quicksand, through which the water forced a passage and, flowing along the nucleus of the ice barrier, prevented its further development. Then the Seine rose, the weak part of the barrier gave away under the pressure and the water invaded the workings. This accident made it necessary to build a coffer dam, 262 feet long, to protect the tunnel during its construction The refrigerating machines were kept in operation during the entire course of the work, and despite the complete immersion of the freezing tubes and the block of ice in the waters of the Seine, the ice remained perfectly solid until the end.

The application of the freezing process was the last act in the long and difficult work of extending line No. 4 across the two branches of the Seine. The slowness of execution has been criticised, but it should be remembered that the peculiar conditions necessitated the invention of new methods, and their continual modification as new and unexpected difficulties arose. The lessons learned will be valuable in future work. For example the method of horizontal boring will be employed in firm, but not in shifting soil The method of constructing the tunnel almost entirely of caissons which has since been adopted in other crossings of the Seine, was also first employed in this line —La Nature

ELECTRIC DRIVE FOR SHIPS

At a recent meeting of the Institution of Civil Engineers of Great Britain H A Mayor a prominent designer of electrical machinery read a paper on application of electric generators and motors for transmitting power from the engines to the propellers of vessels The following is an abstract of the paper

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each The steam turbine and the non reversible internal combustion engine introduce a new set of conditions On land the turbine holds the field for the largest powers and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes its evolution has been directly associated with electrical transmission These turbines are many of them of the same order of magnitude as the turbines used on shipboard and therefore a comparison of economy in the two conditions is inevitable

Land turbines are more efficient than marine turbines for the reasons that the land engineer is freer than the marine engineer to adopt a suitable speed of revolution that the land turbine runs at approximately constant speed for all loads and can therefore be run on the governor rendering easier the application of superheat and augmented vacuum that on land it is possible to subdivide the power units to meet the conditions of varying load and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system that at sea change of power is directly associated with change of speed and the whole of the power units must always be in motion while the ship is in motion The same engine has to run the ship at 10 knots and at 20 knots although the power varies very widely between those limits Also the high economy on land of power production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load giving a complete knowledge of the effect of all changes in the apparatus or in the methods of working it

The proposition here made is to provide an electric equipment intermediate between the prime mover and the propeller extending the limits of practical economy in each by modifying the speed restrictions which the prime mover and propeller impose upon one another and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated At full power all the elements of the generating plant are in full operation and the whole power resources can be concentrated on driving the ship When full power is not required the generating plant may be shut down in sections

To accomplish these results special motors have been designed which give the necessary changes of speed and direction and permit the advantageous combination or elimination of the power generators These motors involve no new electrical principle but simply mechanical adaptation of well known designs Alternating current alone is available for the purpose in

FIG 7—FROST COVERED PIPES

question and normal motors have therefore a fixed speed of rotation which is a simple multiple of the generator speed

Two methods of speed change are proposed each associated with a new form of motor one of these is designated the spinner motor and the other the multiple motor The principle of operation of the spinner motor is that an ordinary normal motor driving the propeller at a fixed speed with the shaft and propeller directly connected is so arranged as to be rotatable as a whole about the propeller shaft axis this rotation being accomplished by a second motor concentrically arranged outside the first so that the main motor system may be rotated in either direction again at a fixed speed which is a simple multiple of the generator speed and the speed of rotation of the propeller shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor

As both motors are reversible there are three speeds in each direction The speed of the main motor system which is the middle speed the speed of the main motor system minus the speed of the auxiliary motor system which is the full speed The combination may be designed for any three speed ratios such as 1 2 3 2 3 4 etc Any intermediate speeds required are attainable by adjustment of the turbine or engine governor which can be operated economically through a range down to about 7 per cent of full speed The same method is applicable to non reversible internal combustion engines

The multiple motor is an ordinary squirrel cage induction motor in all respects except that its stator is wound with two or more independent electric circuits each associated with a separate source of supply of energy For example the motor may be fed from two sources of supply at and cycles respectively the motor windings being for 40 and 9 poles At full power and speed both windings are in operation under the most advantageous conditions each of these windings results in a synchronous speed of revolutions per minute When the cycle current is supplied to the pole winding the speed is 3 revolutions per minute

Either of these motors permits the use of two or more generators together in a single system without electrical connections or synchronizing devices

The author then goes on to discuss the application of electric propulsion to certain definite types of ship and also gives diagram illustrating the saving in space obtained The examples worked out are as follows

1 In a freight vessel of 840 shaft horse power the normal reciprocating engine equipment with a single screw would weigh 0 tons for engines boiler and fuel The proposed equipment consisting of three oil engines and generators three motors and three propellers would weigh only 70 tons including fuel Further with coal at 20s per ton and oil at 40s per ton the saving in fuel cost on a total of £17 would be £5 6s per day at full power

2 In a similar freight vessel gas engines might be used Taking an equipment of 770 shaft horse power and using three gas engines and one multiple motor the respective weights of the normal and proposed equipments would be 446 tons and 229 tons The consumption of fuel shows an equally favorable comparison

3 A third freight vessel but of 1 030 shaft horse power is worked out for the purpose of illustrating the application of the multiple motor to steam turbines One plant drives the ship under normal conditions extra power is supplied by a small turbo-generator and is used to keep up the ships speed in heavy or contrary weather

4 On a passenger vessel of say 16 200 shaft horse power the electrical equipment permits of a subdivision of the plant so that at ship speeds lower than the maximum only part need be run and that at full power This advantage is gained without loss in full power economy and without additional complication

Coating for Autographic Drawing Paper 1 4 parts starch 1 part gum tragacanth parts glue 1 part powdered Spanish chalk ¼ part gamboge 2 10 parts starch paste 4 parts gelatine dissolved in 100 parts water 20 parts Krems white 30 parts starch 2 parts alum ¼ part gamboge 4 123 parts starch boiled to a good paste 60 parts finest glue soaked and boiled 70 parts Krems white in finest powder

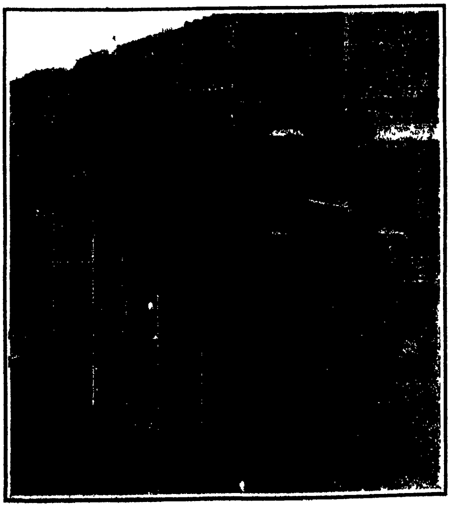


FIG 5—VERTICAL FREEZING TUBES AT PLACE ST. MICHEL.

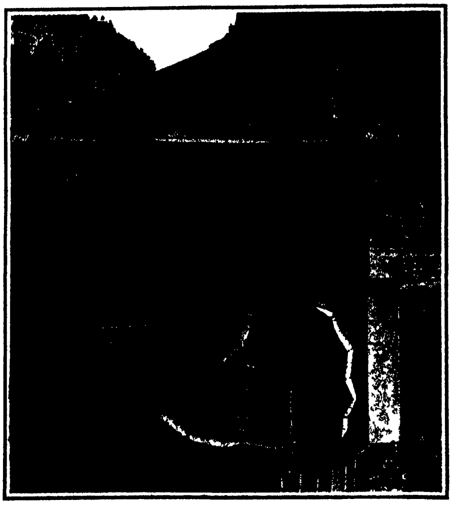


FIG 6—HORIZONTAL BORING MACHINES IN THE CAISSON AT PLACE ST. MICHEL

WRIGHT VS. PAULHAN.

EXTRACTS FROM AFFIDAVITS AND JUDGE HAND'S DECISION IN THE CASE OF THE FARMAN AND BLÉRIOT AEROPLANES.

Concluded from Supplement No 1785, Page 183

FINALLY therefore the novelty of the patent arises and this is the special ground of the defendant's attack I must say that I cannot agree that there has been any acquiescence The number of persons who can fly at all is so limited that it is not surprising that infringers have not arisen in great numbers but considering the possibilities it seems to me that the complainants have had an extraordinary number of contests It is quite apparent that instead of acquiescence they are to meet and have met with a very determined general opposition

Here they must show that the prior art throws no reasonable doubt upon the novelty of their invention The defendant relies upon a number of patents and prior discoveries which I feel obliged to take up in order

It must be observed at the outset that several of the citations are from Mr Chanute's book published in 1894 from which excerpts have been inserted into the moving papers The descriptions given are in the cases where it is relied on too inadequate to constitute valid anticipations under the barbed wire patent 143 U S 275 284 It may be that upon the final hearing the defendant may be able to show these with greater detail but when he does not show them fully enough to enable me to see that there is some reasonable ground to suppose that they were in fact anticipations the presumption arising from the patent must prevail It is not enough that they may have contained some undisclosed elements which might show them to be anticipations In putting the burden of showing the prior art upon the defendant even upon preliminary injunction I am only following the well settled rule in this circuit

D'Esterno The need of caution in regard to evidence of the kind considered in the barbed wire patent *supra* is well exemplified in the case of the description of this machine as well as in that of LeBris It is impossible to say that this had in any sense the combination patented Apparently the wings were to be fixed at a given dihedral angle and the rear parts were merely flexible It would be most dangerous upon the meager and unsatisfactory evidence presented of what the actual machine was to consider that it raised a reasonable doubt of an anticipation Moreover there is no proof that it was ever used or became more than a paper description in which case as I shall afterward show it cannot be regarded as an anticipation

LeBris This is a description of the same kind which is too inadequate to understand or to give effect to So far as one can gather the wings could be set as a whole at different angles of incidence to the wind Here too there was apparently a flexible rear portion of the wings

No one could possibly design either of these machines from the descriptions given and it would be most extraordinary to suppose that they in any sense contained the combination of elements worked out after much experiment by the complainants except by a mere chance that in no sense gave them the necessary vital correlation upon which the patent depends Moreover it does not appear that in the case of either of these devices they were known or used in this country except as Chanute described them and Chanute's description as a printed publication is clearly insufficient to enable anyone to construct them Thus from no point of view are they good anticipations

Mouillard There is a patent in this citation which is a part of the papers and which I have examined In no one of the nineteen claims is there anything that in any way even foreshadows the patent in suit

Indeed the machine which was a glider had no tail whatever and to depress the marginal edge of one wing would have only resulted in entirely disturbing the equilibrium which he might have attempted to restore The depressing of one wing was meant only to turn the aeroplane

Mattullath This was an abandoned patent containing full specifications which described six lateral and supplementary planes three on a side which were adjustable to different angles and were to be used to promote stability At the rear was 'a rudder secured on a vertical shaft It does not appear whether this rudder was fixed or not and the application does not include any use of the rudder to counteract the effect of the differential in the angle of incidence of the supplementary planes The defendant's brief says that this rudder was to enable the machine to wheel to right or left I can find nothing of the sort in the specifications but for the purpose of the argument I shall assume that the vertical rudder was in fact adjustable

As an abandoned patent it was clearly not an anticipation Westinghouse Air Brake Co v Gt North Ry 88 Fed R 26 Dr Zahm swears however that Mattullath showed his designs to many persons It is not enough to show such designs for until the patent be embodied in some practical form it is not an anticipation Ellithorp v Robertson 4 Blatch 307 Det Lub Man Co v Renchard 9 Blatch 293 At most Mattullath's designs were purely experimental and did not give the public that benefit to which it was entitled if the patent in suit is to be held to be anticipated and without consideration Coffin v Ogden 18 Wall 12 Allis v Buckstaff 1 Fed R 871 In the absence of some showing which is not suggested that the complainants borrowed any ideas from Mattullath his discoveries must be held to be no anticipation

Zahm Dr Zahm in a paper in 1894 suggested the use of slats in the wings so as to create a differential in the angle of incidence but it was clearly only an ingenious suggestion and did not in the faintest degree show any comprehension of the complicated reactions and necessary correctives which would alone make the suggestion feasible It was at most only a speculative suggestion never reduced to practical form and falls as an anticipation under the authorities mentioned under Mattullath

Ader The most serious attack upon the novelty of the patent in suit is raised over the machine of Charles Ader a distinguished French engineer a description of which is contained in Revue de l'Aeronautique for 189 This being a foreign printed publication would under the statute be a valid anticipation if it foreshadowed adequately the patented invention

Whatever may have been the merits of the machine described and actually made by Ader it is quite clear that the patented combination was not included or understood by him A reading of his first chapter pp 72 7 is enough to show that he did not regard a rudder as essential It is not correct to say as the complainants do that the vertical rudder was fixed in place The rear wheel could be moved around a vertical axis and was to be so moved to direct the machine upon the ground Une quatrième a l'arrière pour diriger l'aeroplane sur l'air Quand l'aeroplane a un gouvernail vertical celui ci est solidaire de la roue d'arrière et manoeuvre avec elle The cut shows such a gouvernail vertical and we must assume that it was meant to be used and to be turned when the wheel turned

However it is also equally clear that the rudder was no part of the machine M Ader with the characteristic clearness of a French mind enumerates on p 71 the four necessary primary parts of the machine Corps ailes 'force motrice propulseur and these he takes up in four separate chapters The first and shortest chapter concerns the corps de l'aéroplane and enumerates seven constituent parts of which the gouvernail vertical is not one The only mention of it is in the sentence I have quoted in full The whole matter may therefore be disposed of by the single consideration of whether the permissive suggestion of a rudder is to be taken as anticipating the patented combination In so treating the defendant's contention I shall assume that the machine was not an unsuccessful experiment and that there was an adequate and detailed description of its construction which showed that the lateral ends of the wings could be warped to different angles of incidence at the will of the operator

The actual invention of the complainants depends first upon the discovery of the necessary interrelation *per my et per tout* as Mr Justice Matthews puts it in the citation quoted above between the several parts which go to make it up The mere coincidence of these parts by chance or as a matter of taste was in no sense an anticipation of their functional correlation in understanding which the complainants discovery consists and with it their invention When appreciating this necessary co-operation of all the elements they specified their new combination stating the essential necessity of their union and mutual reactions as the very essence of what they claimed they invented something new Ader fortuitously suggested the possibility as matter of preference of the third element the rudder and so shows conclusively that he did not in the least apprehend the mutually dependent relations between wings and rudder. Thus, the patented combination is not in the least merely a new function of one possible form of Ader's apparatus which experience might teach an aviator If the invention be a combination at all and not an aggregation it is such solely by virtue of the apprehension of that vital relation of the parts which Ader conclusively shows he did not have Nothing but his description could more clearly show that with him the three were in merely non functional aggregation Nothing can be more clear than that in the patent they are understood as in inevitable combination

These are the only anticipations cited upon the defendant's brief so that I may assume that he relies in fact upon only these and not upon the others cited upon the argument However a few words will dismiss all the others in case I misunderstand his position

Bechtel Graper Johnson Stanley Marriott These are all for lateral planes to dirigible balloons The whole problem is so entirely different when suspension is effected by a reservoir containing a lighter gas than air that there is not the least resemblance between the patents and the patent in suit Assume the lateral balance of such a machine to be disturbed by a depression of the left side It does not appear that an increase in the angle of incidence upon that side would not be adequate to restore it The resistance so created might have some effect to turn the ship in that direction but the inertia of the body and the friction would be presumably so great that the equilibrium would be restored without any use of the rudder Besides the equilibrium is insured by the fact that in such machines the center of gravity is much below the center of buoyancy as in the case of a ship in water and the planes were designed in all cases simply to cause the ship to rise or fall

Boswell This is a device to be attached to a dirigible airship consisting of a plane adjustable in all directions used in connection with a vertical rudder It is not apparent to me how the tilting of the plane in any of the positions in which it offered no plane of incidence to the drift would cause the ship to turn in one direction or the other nor how if it did it could even then turn it but whatever might be its action it was specified simply as a steering device and it is so wholly unlike the patent in suit both in structure and operation that I can see no similarity between them

Davidson This is an English patent and is not in the least like the patent in suit

Lampson I cannot see any relevancy in this patent

The importance of the issues involved in this cause must be the excuse for so extended a consideration It is of course unusual to grant a preliminary injunction before any adjudication and without any acquiescence However when the right is not seriously attacked and when the infringement is clear the court should not hesitate to interfere From the showing made I cannot doubt that the complainants first put into any practical form the system of three rudder control That there may be other systems is not to the point Let the defendant use those if he will Nor is it necessary to conclude that the complainants were the first to fly" Upon that I decide nothing whatever for it is not an issue in the case All I do say is that I cannot find that anyone prior to their patent had flown with the patented system and that the changes from the specifications which the defendant had made are no more than equivalents which do not relieve him from infringement

It is quite clear that for the complainant's protection a writ must go *pendente lite* because the defendant being a non-resident, who is here only transiently there is no way in which they may insure themselves of the monopoly they have acquired except by preventing his use of it at once

I regret that they have so repeatedly seen fit to accentuate the fact that the defendant is an alien It cannot be necessary to assert that to the determination of the rights of all persons who come before the court that fact is totally unimportant and indeed it is by no means calculated to predispose me in his favor that a citizen should believe it a consideration of importance

The showing before Judge Hazel was substantially the same as that made here and I should have been disposed to say nothing upon the case except to refer to his opinion, had I not thought it fair to give to the defendant the reasons for reaching an independent conclusion.

AERONAUTICS AND ELECTRICITY.

AIRSHIPS, WIRELESS TELEGRAPHY, AND ATMOSPHERIC ELECTRICITY.

BY H. THURN.

Not long after the invention of wireless telegraphy it was proved by Prof. Slaby, in conjunction with the Prussian balloon corps, that wireless signals emitted by a land station can be received by a balloon, floating freely in the air. Similar experiments have since been made in various countries. The balloon "Condor," which made an ascension near Brussels, last year, maintained uninterrupted communication with the station on the Brussels Palais de Justice, and also caught signals sent from the Eiffel Tower in Paris.

Prof. Hergesell, the protagonist of practical aeronautics, had already demonstrated the great value of the application of wireless telegraphy to balloons by controlling the valves of unmanned sounding balloons, at heights extending to ten miles, by wireless electric impulses. The receivers of the balloons were tuned to different wave lengths, so that the valve of any one balloon could be opened, and that particular balloon brought down, at will.

The plan of communicating with passing airships by means of optical and acoustic signals has never been carried into effect, because the zone of communication is very limited and the communication would necessarily be restricted to a few scraps of information, as the compilation and the study of a comprehensive code of signals would be very tedious and difficult. The system of signaling by flags, which is used by ocean vessels, would require the maintenance of signal stations at short distances apart, and the rapid passage of the airships would not give time for extended communications. The adoption of wireless telegraphy would obviate all of these difficulties and would do away with the uncertainty which forms so serious an obstacle to the regular employment of aerial vehicles.

A reliable method of uninterrupted communication with the earth is absolutely necessary for the establishment of practical aerial transit. This communication is necessary for the safety of the airship and the development of its highest value as an instrument of sport, traffic or military service; for the reception of information from military scouting balloons, for the direction of the aeronaut at night and in foggy weather, and for giving him warning of approaching storms and weather changes. An airship provided with wireless transmitting apparatus could also call for assistance when in distress, give notification of its probable time of arrival in port, and forward a statement of the men and material needed for repairs.

The radius of action of a military scouting airship would be doubled by the adoption of wireless telegraphy. In a series of experiments made with the German army balloon "Gross II." in the autumn of 1908, messages were successfully sent from, as well as to, the airship. This first of balloon wireless telegraph stations was constructed according to the "Telefunken" system. It was proved, by preliminary experiments in the balloon shed, that the danger of igniting the contents of the gas bag by the sparks emitted by the wireless telegraph apparatus could be averted by taking suitable precautions. This danger is least with airships of the flexible and semi-rigid types, in which the gas bag possesses very few metallic parts which could draw sparks from the highly-charged aerial. The suspension of the car of the "Gross" by hempen ropes insured the complete insulation of the electrical apparatus from the gas bag, and all parts at which sparks were formed were inclosed in gas-tight envelopes. For military reasons, the details of these experiments have not been published, but the results are said to have been very satisfactory.

These experiments have proved that electromagnetic waves are propagated to great heights in the atmosphere and that the part played by the earth in wireless telegraphy is far less important than has been assumed. Thus the principal theoretical objections to the application of wireless telegraphy to airships have been removed.

In the German army maneuvers of last year the "Gross II." demonstrated, for the first time, the practical utility of wireless apparatus on a scouting balloon. The Zeppelin airship which took part in the maneuvers did not possess this advantage. Since that time, however, the "Zeppelin III." has been equipped with wireless apparatus, and it has been proved that, even from a metallic airship of the Zeppelin type, wireless signals can be transmitted with safety to a distance of 300 miles or more. All of the newer Zeppelin airships are provided with wireless apparatus.

Let us now examine the dangers to which a metallic airship is exposed from atmospheric electricity and the employment of wireless telegraphy, and the protective measures which have been proposed. The chief source of danger is the inflammable gas with which the balloon is filled. In a thunder storm a balloon is subject to sudden variations of electric charge which may produce sparks capable of igniting its gaseous contents. Wireless signals are accompanied by equally great and rapid changes of potential, which may produce the same result.

It is probable that the destruction of Zeppelin's airship at Echterdingen was due to atmospheric electric discharges during a thunder storm. The catastrophe which, in September of last year, befell the French dirigible balloon "République," which fell to earth from a height of more than 300 feet, appears to have been caused by the breaking of a propeller blade, which tore a hole in the gas bag and to the subsequent ignition of the escaping gas by spark discharges between it and the large metal parts of the semi-rigid airship. It is a well-known fact that gas or steam, in escaping rapidly from an orifice, acquires an electric charge which may produce powerful sparks.

As the gas cannot be ignited by discharges from the canvas gas bag, the netting, ropes and similar poor conductors (unless they are converted into good conductors by becoming saturated with water) but can easily be ignited by sparks from the metal parts of the valve and other masses of metal, it is obvious that all metals and other good conductors should be eliminated from the gas bag. There is no objection to carrying metals in the gondola, and a well-conducting drag rope is a safeguard against the danger of explosion in landing. If all good conductors are banished from the immediate vicinity of the gas bag, there would appear to be no danger in the application of wireless telegraphy to airships of the flexible type. If the same precaution is taken, these airships are no more liable than ordinary motorless balloons to ignition by atmospheric electrical discharges.

In rigid airships with metal frames the conditions are altogether different. In an article published in the Electrotechnische Zeitschrift [translated in Scientific American Supplement, No. 1762, October 9th, 1909] Dr. Zehnder has shown that in the Zeppelin airship, with its aluminium frame and its numerous gas bags filled with hydrogen, every condition of easy ignition is satisfied. Between the great cylindrical conducting frame, which is more than 400 feet long and more than 40 feet in diameter, and the surrounding air may exist a difference of potential of 65,000 volts when the airship is horizontal, and of 500,000 volts when it is steeply inclined. A spark capable of causing ignition can be produced by a potential difference of 3,000 volts. As it does not appear practicable to substitute wood for aluminium in the construction of the frame, Zehnder recommends protection of the airship by lightning rods projecting beyond the reach of escaping gas. He also suggests making the gas container of sheet metal, the stiffness of which might make it possible to employ a lighter skeleton and keep the total weight at its present value. No electrical discharge could take place inside this metal envelope and the induced surface charge would escape harmlessly into the atmosphere from projecting seams and points. As an additional precaution, the aluminium gondolas could be connected with the metal balloon by a number of wires so that the aeronauts would be inclosed in a sort of Faraday's cage which would protect them from external electrical influences.

In regard to the employment of wireless telegraphy on the Zeppelin airship in its present form, Solff suggests an arrangement of the aerial which would minimize the danger of ignition and would also furnish the best electrical conditions for the transmission of signals. As the hull of the Zeppelin airship is traversed by a vertical shaft or well, it is possible to support the aerial by a simple Eddy kite, which would be kept aloft by the motion of the airship. The wireless apparatus, including the dynamo, would be housed in the middle of the runway which connects the two gondolas. The kite would be connected with the apparatus by a wire from 600 to 1,200 feet in length, i. e., one-fourth or one-fifth the length of the electric waves employed. A second wire, of the same length and weighted at its lower end, would hang downward from the apparatus and would be kept as nearly vertical as possible by insulated stay lines attached to the gondolas. The lower wire might, however, be advantageously replaced by a fan-shaped antenna about 200 feet long, attached to the frame of the airship and projecting about 30 feet below the hull. With this arrangement telegraphic communication would be possible even when the airship was flying very low. Fouling of the propeller by a broken wire could be guarded against by inclosing the propeller in a protecting frame.

The T-shaped antenna which is carried by ships using the Telefunken system could also be applied without difficulty to the Zeppelin airship, as the metal frame is abundantly able to carry a light, hollow mast about 30 feet high, which could be raised and lowered by ropes. The stability of the airship, however, would be affected by this rather complicated apparatus more than by the kite device.

As experiments made with both the military airship and the Zeppelin airship have demonstrated the feasibility of maintaining wireless telegraphic communication between airships and the earth, we may hope that in the future, wireless telegraphy will play as important a part in aeronautics as it does in navigation. An indispensable prerequisite to its adoption, however, is the electrotechnical development of means of protection from all danger of injury by the working of the apparatus or by atmospheric electricity.—Translated for Scientific American Supplement from Umschau.

COLORS OF SEA AND SKY.

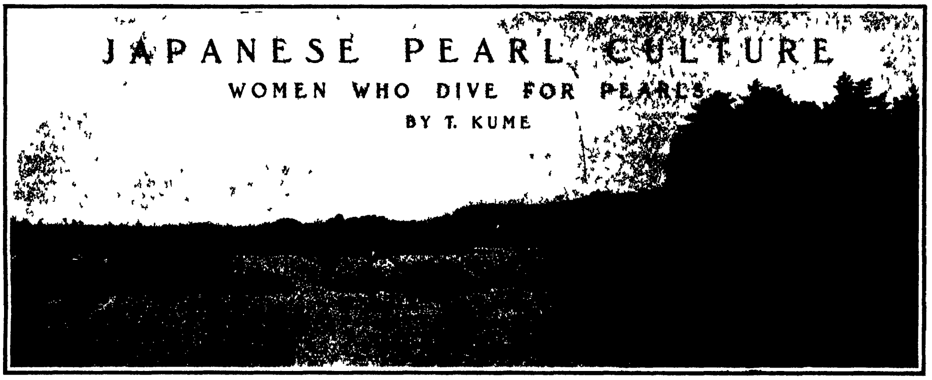
The Friday evening lecture at the Royal Institution was given by Lord Rayleigh, whose subject was the "Colors of Sea and Sky."

Lord Rayleigh pointed out that for the color of a liquid to be seen properly the light must go through it; hence a deep-colored liquid did not readily show its color. The application of this fact to the color of the sea was direct. The color of the sea was often supposed to be a beautiful blue; that no doubt was what was seen in certain circumstances; but it was due, not to the intrinsic color of water, but to the reflection of the sky. The deep blue color of the sea often came out well when the water was rippled, because then, of the light seen reflected by the observer, more came from the zenith than would be the case if the water was perfectly smooth. With bigger waves, again, it was easy to recognize that the front slope of the wave showed the best blue. The true color of the sea might be seen in rough weather, when looking through a wave with the sun behind it, the observer would perceive no blue, but a fully developed green. In shallow water the reflection of the light from the bottom revealed the true color of the water, except so far as it was affected by the color of the bottom itself. Davy was probably the first to state that the color of water was blue, a conclusion also arrived at by Bunsen. The Belgian physicist Spring made elaborate experiments with water contained in tubes so long as 26 meters, and he described the color as a beautiful blue, comparable only to the purest blue of the sky. But the water must be pure, or it looked green or even yellow. Another inquirer into the question was Aufsess, and one of his observations was that for the blue and violet end of the spectrum, water was almost perfectly transparent, which would sufficiently explain its blue color. Lord Rayleigh himself had carried out some experiments with tubes 12 feet long, and he pointed out the importance of the light used for illuminating them, since a little blue in that light made a great difference to the blueness of the color perceived in them. Experimenting with water from Capri and from Suez he got a color which might complementarily be called blue, but rather was greenish blue, while that from the Seven Stones Lightship, off the Cornish coast, gave a full green. With carefully distilled water he got only the same degree of blueness as with the water from Capri and Suez. Turning to the blueness of the sky, he upheld the view that it was due to the dispersal of light by small particles. Spring's view, that it was due to the effect of chemical matter in the air acting by absorption, he thought was disproved by the fact that the setting sun was red, not blue, though it might be that constituents of the atmosphere, such as oxygen, acted as a secondary cause. The general idea was that the cause was dust, particles of water, etc., but he thought there was no reason to doubt that for the most part the blue of the sky was due to the dispersal of light by the molecules of the air.

JAPANESE PEARL CULTURE

WOMEN WHO DIVE FOR PEARLS

BY T. KUME



THE SHELTERED BAY OF AGO WHERE WOMEN DIVE FOR PEARLS.

Whether or not there were any pearls in prehistoric Japan and if so whether these pearls were used for ornament as in our day is unknown Even in Japanese tradition and history the ancient references to precious stones and particularly to pearls are by no means clear In the Kojiki or the Book of Tradition the oldest written history of Japan dating from the seventh century a word is to be found standing for the present pearl or Shinju in Japanese In the epic of the goddess Tamayorihime a description will be found of a white jewel by which a pearl is meant Still another reference is to be found in the story of the goddess of the sea in her meeting with the god Hiorino mikoto where giving a pair of jewels from the sea is mentioned Indistinct as these mythological references are there seems to be no doubt that pearls were known even in ancient Japan

That this should be so would follow from the very nature of the country Japan is composed of a group of six large and numerous small islands incessantly washed by the warm waters of the Pacific In mythological times the people were more or less barbaric There were no houses no roads no commercial or political intercourse The inhabitants dwelt in caves near the seashore They settled in one place and stayed there until their food supply was exhausted Then they removed to another place where again they took up a temporary habitation No doubt sea food was their chief nourishment and above all shell food After the flesh had been eaten the useless shells were thrown aside at the entrance of the caves Thus the Japanese account for the innumerable mounds of shells which are to be found near the seashore In these shell mounds no pearls have been found yet it stands to reason that if pearls were ever abundant in these prehistoric times they must have been discovered and prized

In the reign of the twentieth Emperor Inkyo which began in the fourth century the pearl was undoubtedly known In the Nippon Shoki published 720 A D the oldest history after Kojiki we read In September of the fourteenth year the Emperor Inkyo went to the island of Waji to hunt Wild animals were abundant at that time but not one could be killed All escaped Then the god of the island said to the Emperor It is I who have hindered the chase There is a pearl at the bottom of the Sea of Akashi Obtain that and worship me with it and I will let you hunt to your fill

And the Emperor gathered about him all the skillful divers that he could find but not one of them was successful Finally there came a diver from the Province of Awa whose name was Osashi He wound a long rope around him and leaped into the water After a few minutes he came up and said There is a big Awabi shell twinkling at the bottom of the sea Then all exclaimed That is the very thing for which we are seeking That must be the very pearl prized by the god of the island

Then the diver Osashi plunged in again and after a while he came to the surface with a giant Awabi shell At the very moment that he touched the shore he lost breath and died When they sounded the water by means of a rope they found it to be sixty fathoms deep In the giant shell was found a pearl the size of a peach

Exaggerated as this story is it contains a suggestion of pearls and moreover the suggestion that pearls were highly prized But in the Nippon Shoki there are many references to the existence of pearls and their use as personal ornaments

Japan has long yielded the most beautiful specimens of Oriental pearls In Marco Polo's Island of Chipangu published in 1298 we read They have also pearls in abundance which are of a rose color but fine big and round and quite as valuable as the white ones In this island some of the dead are buried and others are burned When a body is burned they put one of these pearls in its mouth Since Marco Polo's time Kaempfer Tavernier Thunberg and others have written of the beauties of the Japanese pearl

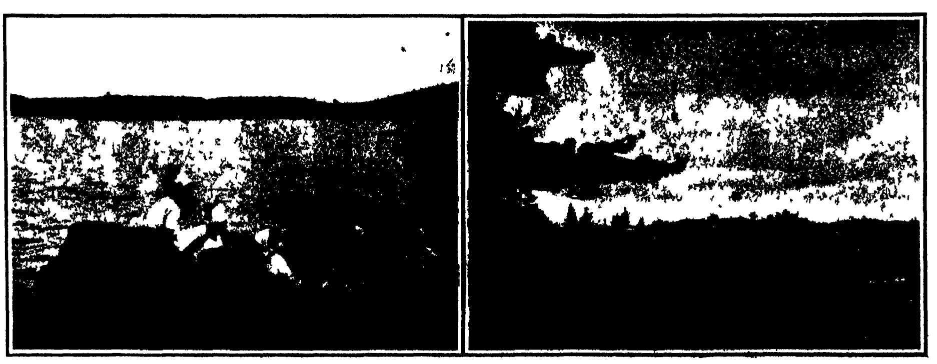
In ancient times Japanese pearls were used more for general decoration than for personal adornment They were to be found in old lacquer work desks furniture or cloisonne work inro netsuke tobacco bags, and sometimes in sword handles One of the oldest pearls used for ornamental purposes is mounted in the statue of the goddess Kannon kept in the Sangetsudo Temple at Nara Still another is to be found among the imperial treasures kept in the Shosoin Temple of Nara These two gems are said to have been deposited in these temples during the Tempyo age (A D 729 748) and are probably the oldest pearls now in Japan

The history of Japan contains not many references to the use of pearls in connection with feminine jewelry Evidently in ancient times there were no brooches bracelets rings or pendants Only the hair was ornamented Hence it is that large pearls in old Japan were used only for hairpins and for tobacco bags and for string fasteners and that many valuable pearls were lapped in cloth This lapping was attended with not a little superstition When two pearls were thus lapped together it was thought that they would multiply in time Still another superstition was that a pearl wrapped in a cloth was regarded as a family treasure the possession of which insured prosperity to the family More curious than these customs is the use of pearls as a medicine The ancient Greeks were in the habit of drinking pearls to improve the skin The ancient Japanese took them into the system to improve the eyesight

In the last ten years the Japanese have altered their opinion of pearls Never in the history of the country has the pearl been more highly prized as an article of feminine adornment than at present Pearls are used largely in the Obidome or obi fastener embroidery and the like

There are many species of pearls in Japan Among the shells which produce pearls here given by Dr T Nishikawa are the true pearl oyster (Margaritifera martensi) black lipped shell (Margaritifera margaritifera) electroma sp Margaritifera panasse Mytilus crassitesta Pecten yessoensis Haliotis gigantea Unionidae or Naiades Corbicula Pinna Soden Arca Tridacna Ostrea Tapes Cytherea Trigonella Mactra Mellina Pecten Rapana Turbo Haliotis Cassis rufa

This list comprises some of the best known species Among these species, Margaritifera martensi, Margari-



The women [illegible] Bay of A[illegible] [illegible] Bay [illegible] when they reach the age of thirteen or fourteen years learn to dive for pearls Their native towns and villages lie along the seashore They are in the water almost all the year

THE WOMEN PEARL DIVERS OF JAPAN.

tifera panassæ, Mytilus crassitesta and Haliotis gigantea, Unionidæ yield some of the finest pearls. The best of the so-called oriental pearls are obtained from M martensi black blue and sometimes greenish pearls from M margaritifera, yellow pearls chiefly from M panassa and black or dark pearls from Mytilus crassitesta and beautiful pinkish and greenish pearls from Haliotis gigantea most of the pink pearls however are obtained from Unionidæ.

M margaritifera and M panassæ are limited to the region of Ryukyu Islands in the southern part of Japan and Unionida to the Lake Biwa and also the Lake Kasumigaura. The others are to be found almost everywhere on the coast. Ago Bay in the province of Shima Omura Bay in the province of Hizen Takaoka Bay in the province of Tosa Nanao Bay in the province of Noto the islands of Awaji the island of Tsush Tsushima are most famous for their yields of M margaritifera and martensi.

JAPANESE ARTIFICIAL CULTURE OF PEARLS

Recently the Japanese thanks to the energy of Mr K Mikimoto have inaugurated a new industry which is nothing more nor less than the artificial culture of pearls. Everyone has no doubt often seen shells of mollusks lined with a smooth and iridescent coating which is called *nacre* or mother of pearl. This coating like the rest of the shell is produced by the animal and is made up mostly of carbonate of lime and an organic matrix which usually presents a laminated texture. The color and brilliancy of this layer differs in various species of shell. For instance in the ordinary oyster it is of a lusterless white and in a kind of shell called *abalone* or ear shell (Haliotis) the nacre is of a greenish blue tinge, changing to purple as it is turned. In the black lipped shell (Margaritifera) the mother of pearl is of a greenish black color. In the shells of the true pearl oysters the nacre is of a clear delicate white which has the sheen of floss silk faintly tinted with azure exhibiting a beautiful play of color—a quality which makes these shells of great value in commerce.

Now it often happens that foreign substances such as sand grains microscopic organisms of various kinds parasitic worms crabs or sometimes even small fish are introduced by accident or otherwise inside the shell or in the tissues of the mollusk's soft body. In such cases the animal sometimes begins to deposit a part of the material which goes to form the nacreous layer of the shell around or over these foreign objects and as new material is added year after year in the form of layers these concretions which may at first be very tiny grow to be of a considerable size. When this takes place in a shell with specially beautiful nacre such as that of the pearl oyster the result may be an object of great beauty. In this strange way pearls are produced.

Such being their origin pearls may be formed in any kind of mollusk bivalved or spiral. And just as the nacre of different kinds of shells differs so the pearls themselves vary according to the shell which produces them. Thus the pearls of the common oyster, the scallop and the giant clam are milky white and not very bright while those of the sea mussel are usually black. The chank and the conch shells produce the pink pearls which are brought from the Bahamas and the West Indies. These pink pearls are also found in several kinds of fresh water mussels, which are plentiful in some of the streams and lakes of America, Europe, China, and Japan. Most superb of all however are the products of the true pearl oysters. These are the pearls which have always been called oriental pearls— solidified drops of dew the poets have named them.

Pearls are of many different shapes some round some pear shaped some egg shaped and some of very fantastic shapes indeed. The round pear shaped and egg shaped ones are known as oriental or virgin pearls while those of irregular shapes are called baroque pearls. These are sometimes found in the shapes of fish birds wings or creeping worms. The seed pearls generally used as medicine by the Chinese are always very small and usually found together in numbers.

Sometimes two pearls will be found joined together by the nacreous substance thus forming what is known as twin pearls.

All these are called free pearls because they are found in the tissues of the animal's body and are not joined to the shell.

In the same way that twin pearls are joined it sometimes happens that pearls are found attached to the inner surface of the shell. This position interferes with the symmetry of the pearl so that when it is taken out of the shell it is flat on one side making what is known as a perle bouton. The attached pearls are not always of inferior quality but are often highly valued. The world renowned Southern Cross which was valued at $50 000 by the company to which it belonged was found off Cossack western Australia attached to the central part of the inside of a shell.

CULTURE PEARLS

When once the nature of pearls was understood it was but natural that many experiments should be made to produce the precious objects at will. We do not here refer to the manufacture of artificial pearls such as the so called "Roman pearls Venetian pearls etc which are not pearls at all but are made of glass and painted with fish silver rather what is referred to are the attempts to make the pearl oyster work for man and produce natural and true pearls in a reliable and methodical manner in short a kind of harnessing the mollusk for the service of man.

It is well known that Linnæus the father of natural history claimed that pearls could be obtained by piercing holes in the shell of an oyster with a fine auger making a small wound and afterward parking the animal for many years. But his suggestions do not seem to have been clearly understood and no one has been able to pursue his method successfully. The Chinese as is well known have been specially successful in raising pearls by inserting grains of clay between the shell and the thin outer membrane which covers the soft body of the fresh water mussel but the best of these are of very inferior quality and are valuable merely as curios.

At the International Fisheries Exhibition held in Berlin in 1880 some pearls were shown which had been cultivated in Germany. From looking at these one could see that the plain relief might be covered with nacreous substance but the result was of little value. Mr Saville Kent late naturalist to the government of Queensland and to that of western Australia undertook the same experiment with the large pearl oyster and a gentleman on Thursday Island tried inserting a shot through a hole in the shell.

The most important of such experiments are probably those of Dr Louis Boutan of Paris who succeeded some six years ago in producing pearls in the abalone shell. The public was naturally greatly interested and the newspapers in Europe and America applauded his success and called it a great discovery.

It may perhaps come as a surprise to many that before Dr Boutan's attempts a very extensive and successful system of pearl oyster cultivation had been carried on in Japan by a Mr Mikimoto and culture pearls had not only been produced but placed regularly on the market. Even at the present day it may be claimed that this is the only pearl oyster farm in the world which undertakes the extensive cultivation of the precious mollusk and produces culture pearls on a commercial scale. An account of this successful enterprise may therefore be not wholly devoid of interest.

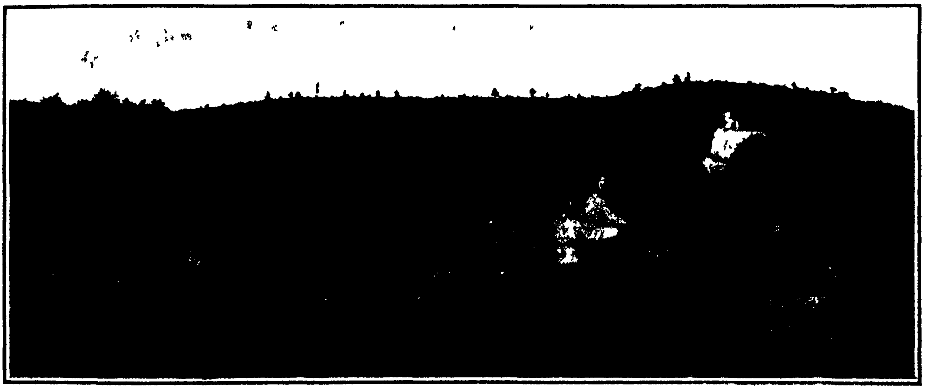
THE HISTORY OF THE JAPANESE CULTURE PEARL

At the Third National Industrial Exhibition held in Tokyo in 1890 Mr Mikimoto exhibited in the aquarium of the fisheries section some living specimens of the pearl oyster. This made him acquainted with Dr Mitsukuri professor of zoology in the Imperial University who first suggested to him the possibility of cultivating pearl oysters and of making them produce pearls by the use of proper stimuli. Being deeply interested in the subject Mikimoto went afterward to the Marine Biological Station of the Imperial University at Misaki where the professor was staying and learned from him many facts concerning pearl formation and the natural history of the pearl oyster.

Mikimoto's home was Toba in the province of Shima one of the localities in Japan famous for large yields of pearls. Directly after his return there he began experimenting on his idea. At first it seemed almost like pursuing a fleeting shadow, and his friends laughed at him for "throwing his money into the sea." However he persisted making all sorts of experiments and changing his methods from time to time relying on suggestions and advice from Prof Mitsukuri and Dr Kishinoue. At the end of four years of hard work disappointment and renewed efforts some results were obtained which seemed to promise success. In 1896 things had so far progressed that the experimental stage was a thing of the past and the enterprise was put on a commercial basis. A patent for the new method was obtained from the government and the cultivation of the pearl oyster on an extensive scale was begun at the island Tatokujima in the Bay of Ago leased some time before for the purpose. At the end of 1898 the first though small crop of pearls was harvested and placed on the market. These have been given the name of culture pearls by Prof Mitsukuri. Since then the enterprise has been steadily growing in every way and the skill and experience obtained by handling millions of pearl oysters have enabled the establishment to maintain a constant improvement in the quality of the pearls produced.

THE PEARL CULTURE FARM

About a dozen miles south of the famous Shrine of Ise is the sheltered Bay of Ago long famous for producing the best quality of pearls. It is a remarkably quiet body of water some six miles in length and three miles in breadth with an average depth of ten fathoms although it is over twenty fathoms deep near the entrance. The coast line is cut into with many deep and irregular indentations which besides affording excellent shelter and ground for the pearl oyster have the additional merit of making the scenery exceedingly picturesque. The fact that the Kuroshiwo the great "gulf stream" of the Pacific sweeps near by



The women pearl divers of Japan wear a special dress. The hair is twisted into a hard knot and the eyes are protected by glasses. The oysters are dropped into tubs suspended from the waist.

THE WOMEN PEARL DIVERS OF JAPAN

is also undoubtedly an important factor in making this a favorite haunt of the precious mollusk

Somewhat to one side of the middle of the bay toward the north is the small island of "Tatokujima," the center of Mikimoto's enterprise When first taken possession of it was uninhabited, but now it supports a flourishing colony of several dozen families and many hundred individuals all connected in some capacity with the pearl oyster culture The sea bottom around the island was at first leased, the area being increased from time to time until finally in 1903 and also 1905 the government, recognizing the importance of the enterprise, granted the use of a very large portion of the bay, so that at the present day, the whole of the sea area leased by Mikimoto extends for 29 nautical miles

The pearl oyster cultured on these grounds belong to the species (M martensi) abundant in the Bay of Ago and found more or less in all parts of Japan They closely resemble the Indian species found near Ceylon, famous for producing the finest pearls in the world These mollusks live at depths not exceeding seven fathoms, and are anchored to rocks, stems of algæ, etc, by threads which the animals secrete

The methods practised at Mikimoto's farm are as follows

Every year during the months of July and August small pieces of rock and stone are placed in spots where the larvæ of the pearl oysters have been found to be most abundant Soon small oyster spat are found attached to them As this takes place in the shallow waters of not more than a few fathoms, they would die from cold, if left there during the winter; so together with the rocks to which they are anchored they are removed to deeper waters and carefully laid out in beds prepared for them Here they lie until they reach their third year, when they are taken out of the sea and undergo an operation which leads to pearl formation This consists chiefly in introducing into them the small pearls or round pieces of nacre which are to serve as the nuclei of pearls The shells are then put back into the sea and left undisturbed for at least four years more At the end of that time, they are taken out, and it is found that the animal has invested the inserted nucleus with many layers of nacre and has in fact produced a pearl

Pearl culture as we have described it may seem to be very simple, but in reality it is by no means an easy work. Large mortality among the pearl oysters from various causes, the ejection of the inserted nuclei, the depredations of the oysters' enemies, uncertainties attendant upon long years of waiting, are some of the drawbacks which beset the industry The most dreaded of all the evils is perhaps the invasion of the so-called "red current" This has been ascertained to be due to an immense accumulation of microscopic organisms causing a discoloration of the sea water Wherever this appears it is followed, for some reason not yet well understood, by a wholesale destruction of marine organisms, and when it invades the pearl culture grounds, it may undo in one day the work of years. Another unwelcome intruder of the culture ground is a sea weed called "Mirumo" (Codium), which if allowed to grow luxuriantly will cover up the pearl oysters and stop their growth or even kill them by smothering them, so to speak Again the octopus plays sad havoc among the pearl oysters which it seems to consider a great delicacy The starfish is another animal which especially enjoys a meal of pearl oysters

THE WOMEN PEARL DIVERS OF JAPAN

Every country has its own particular method of catching fish and shell fish and so has Japan Among the many different methods employed in Japan for pearl fishing none is more interesting than that employed by the women divers, who obtain the pearl oysters Pearl fishing is conducted mainly by men divers in Australia and India and other countries, but in the region about Ago Bay in the province of Shima, the Bay of Gokasho in the province of Ise, as well as in other parts of the country, women are employed in diving Still the general tendency nowadays is to engage men wherever possible. The women along the coast of the Bay of Ago and the Bay of Gokasho, when they reach thirteen or fourteen years, by which time they have completed a primary school education, go to sea and learn to dive Thus they are trained more or less from childhood in their vocation Their native towns and villages lie along the seashore Hence it is but natural that they should all dive and swim almost from babyhood. They are in the water almost all the year round, except in the coldest season, from the end of December to the beginning of February Yet even during this inclement season they sometimes dive for pearls. It goes without saying that the climate in these regions is almost always mild, and that snow is almost unknown in winter. These women divers wear a special dress. White underwear is worn, and the hair is twisted up into a hard knot The eyes are protected by glasses to prevent the entrance of water. Tubs are suspended from the waist A boat in command of a man is assigned to every five to ten women divers to carry them to and from the fishing grounds When the divers arrive on the grounds they leap into the water at once, and begin to gather oysters at the bottom. The oysters are dropped into the tubs suspended from their waists When these vessels are filled, the divers are raised to the surface and jump into the boats

The Mikimoto pearl farms lie at a depth of from five to thirty fathoms, with an average of ten fathoms. The women dive to the bottom without any special apparatus, and retain their breath while they remain under the water They stay under the surface from one to three minutes When they are chilled they return to the shore, and warm themselves at fires built in huts especially for the purpose, and then return and resume their work The women engaged in this work vary in age from thirteen to forty years. Women from twenty five to thirty five make the best divers because of their physical strength and experience. The hours of labor vary with the seasons In warm summer weather about six to eight hours constitute a day's work In cold weather the divers cannot work more than from one to two hours The wages paid range from ten cents to fifty cents a day The highest ever paid is one dollar Astonishing as it may seem, some of the women manage to save considerable money, largely because the cost of living is very low. Most of the young divers try to earn their marriage dower by diving Even after marriage many of them support their families by diving Skill in diving is a woman's greatest possession Most of the pearl fisheries are situated in small inlets flanked with evergreens The water is wonderfully clear. There is something indescribably picturesque in the aspect of divers plunging into the glassy water, and sending out ripples in all directions Their curious whistle as they inhale and exhale on entering and leaving the water has something uncanny about it

THE EXPANSION OF AIR BY HEAT.

SOME SIMPLE EXPERIMENTS.

If a bladder, partly filled with air and with its neck tied tightly, is laid on a hot stove it will soon become filled completely and it will burst with a loud report if it is heated very hot or has been nearly filled with air in the first place As the same confined mass of air which only partly filled the bladder when cold fills it completely and "to the bursting point when hot this simple experiment gives a striking proof of the fact that air expands when its temperature is raised

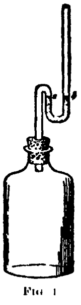


FIG 1

The following experiment shows that even a slight increase of temperature produces an appreciable expansion A glass tube softened by heating in the flame of a spirit lamp or a Bunsen burner, is bent into the form shown in Fig 1, and, when cold, is accurately fitted to a hole bored through the tightly fitting cork of a small bottle A little colored water is poured into the tube, of which it fills the U shaped portion which is shaded in the illustration, forming a water seal and preventing communication between the air in the bottle and the external atmosphere If the bottle is clasped with the hand the level of the water rises in the branch *b* and sinks in the branch *a* because the water is driven along the tube by the expansion of the confined air by the heat which it receives from the hand

The appearance of vibration or "shimmering" which is observed over a hot stove, and over paving stones exposed to the sun in summer, is caused by the ascent of air which is expanded and consequently made lighter by contact with the heated stove or stones Spiral strips of stiff paper and more elaborate constructions containing inclined surfaces are often mounted on pivots over stones where they are caused to rotate rapidly by these upward air currents

The ascensional force of heated air is shown still more strikingly by the following experiment Strips of tissue paper are pasted together to form a bell, which is hung over a tripod, as shown in Fig. 2 A single upright rod may be used instead of the tripod, but the rod should carry at its top a rather large disk in order to keep the mouth of the bell open If a large spirit lamp or, preferably, a little cotton wool placed in a cup and saturated with alcohol, is set beneath the mouth of the bell and lighted, the paper bell will soon become inflated with hot air and will rise to the ceiling The bell is in fact, a hot air or fire balloon the oldest of all balloons which was invented by the brothers Montgolfier more than a century ago The Montgolfier balloon was made of paper yet these pioneer aeronauts dared to intrust their lives to it, and thus made the first balloon ascension, from Lyons, France, in 1783 The balloon was filled with smoke produced by burning wet straw and wool The Montgolfiers thought, until they were convinced of their error by men better versed in science that this smoke possessed electrical properties which increased its lifting power —Kosmos

A SIMPLE METHOD OF ELECTRO-PLATING.

AT a meeting of the Royal Society of Arts on February 2nd, a paper by Mr A. Rosenberg was read upon an improved method of electroplating Mr Rosenberg dispenses altogether with the plating bath and all external sources of electricity. The plating is carried out simply by rubbing on a powder moistened with water The process is really a refinement of the old contact method It will be remembered that in this process a piece of metal which it is desired to plate upon is immersed in an electrolyte, for example, one containing a silver solution In contact with this metal a more electropositive one is placed, also dipping into the electrolyte This metal usually zinc, passes into solution, and an electric current thereby is generated The silver is then plated-out upon the less electropositive metal

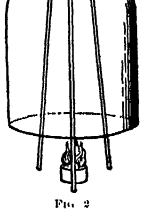


FIG 2

Mr Rosenberg employs his electro-positive metal in the form of a fine powder, and generally uses magnesium This is mixed with a metallic salt or with the powdered metal it is desired to plate-out, and ammonium sulphate or other ammonium salt In order to plate a piece of metal the powder is moistened with water and rubbed over its surface by means of a piece of rag or a brush. By this means adherent and bright deposits are obtained in about one minute, the thickness of the deposit depending upon the time employed and the quantity of powder used.

The magnesium, being strongly electro-positive, reacts with the moist electrolyte, and goes into solution, causing the metal to be plated-out upon the metallic surface which is being rubbed. In other words each particle of the powdered magnesium may be said to function as a minute anode. One of the difficulties in electroplating is to plate a substance upon itself. It is easy enough to give it almost any thickness of deposit, but if the spoon is once withdrawn from the bath and used it cannot be plated further without first stripping off the old deposit. Mr Rosenberg claims that with his process this difficulty does not occur.

Another great difficulty in electroplating is the cleansing of the article to be plated, the least trace of grease, even that produced by handling, for example, will prevent an even and adherent deposit. Consequently, articles have, as a rule, to be chemically and mechanically cleaned before being put into the plating bath. With the powder Galvanit of Mr Rosenberg this is not necessary because the act of rubbing the powder carries out its own cleansing.

The author's object has been to produce a household method of plating. Thus when the tinning of saucepans is worn out the householder has only to polish the inside with the moist tin Galvanit to retin the saucepan. Spoons from which the silver plating is partly worn can be replated. The nickel Galvanit can be used for bicycles and so on. Mr Rosenberg demonstrated the process before the meeting by plating an iron tube with cadmium, a copper tube with nickel, a penny with silver, and a brass tube with tin.

Galvanit can also be used for nickel facing electrotypes. The process is certainly ingenious and will no doubt be found useful for small work, but it is hardly likely to enter into competition with ordinary electroplating for large work or for irregular articles. Nor is it likely to be employed in cases where heavy coatings of metal are required, because it would not be an easy matter to rub on sufficiently evenly to obtain uniform and thick deposits.—Nature.

A NOVEL HYDROCARBON ENGINE.

A VARIABLE-STROKE GASOLINE MOTOR FOR AUTOMOBILES.

EVEN the best constructed gasoline motor is greatly lacking in the elasticity that characterizes the steam engine. To obtain the highest efficiency with a gasoline motor of ordinary construction the compression pressure and piston speed must be equally considered. All gasoline automobiles are provided with a transmission gear for varying the speed, by means of which a certain variation of the speed rates of transmission (Uebersetzungsverhaltnisse) between the speed of rotation of the motor crankshaft and the driving wheels is secured.

This disadvantage does not attach to the steam engine, because the turning moment may be increased or diminished by the mere regulation of the pressure of the steam upon the piston. There have been numerous attempts at the construction of an internal combustion motor for automobiles in which the necessary variation of the ratio between the crankshaft speed and that of the axle of the driving wheels could be attained without the employment of the usual transmission gear. Most of these have been unsuccessful, but a new type of motor has recently been brought out in which the piston stroke may be varied while the volume of gas expelled by the piston bears constantly the same ratio to the entire working capacity (Arbeits Kapazität) of the cylinder, i. e. the compression remains constantly about the same, and the difference in compression as between the longest and the shortest stroke is only about per cent. This motor is the invention of two English engineers, Messrs. Gill and Aveling, and they claim that it offers a perfect solution of the direct drive problem upon gasoline automobiles. The motor, however, has not yet been tried in practical use on an automobile.

The accompanying illustrations reveal clearly that the principles of the motor cylinder, combustion chamber, inlet and exhaust valves, water cooling and many other details are identical with those of the ordinary gasoline motor, but the crankshaft ends of the connecting rods *A* are not fastened to the crank shaft. Instead they are attached to pins *B*, which fit between the forked ends of other connecting rods *H* that extend horizontally to the crankshaft.

Each pin *B* is fastened radially by means of a pair of connecting rods *C*, and the motion of the pin is confined to a path determined by a quadrant placed above the crankshaft. The shaft *D* is provided with square sections through which pass the threaded rods *F*. By turning these shaft *D* can be raised or lowered in the sector *E*. Rods *I* are turned by means of a longitudinal shaft and bevel gears *G* placed above the motor. In a four-cylinder motor the shaft extends the entire length of the motor.

The 50 horse-power motor shown has four cylinders, each of 125 millimeters bore. The stroke varies between a minimum of 50 millimeters and a maximum of 188 millimeters. It gives about 50 horse power.

The three diagrams give the relative positions of the connecting rods *A*, *H* and the tie rod *C* for the strokes of 50, 112 and 188 millimeters (2, 4½ and 7½ inches).

The full lines represent the position of the rods when the piston is at the highest point of the stroke, and the dotted lines their position at the lowest point of the stroke, while the three rectangles of the figures indicate the volumes of gas corresponding to the three lengths of piston stroke.

The diagrams show still another thing. If we take for a standard of comparison the upper piston edge in the left of the three drawings it will be seen that in proportion as the stroke increases the piston in its highest position is at a lower point in the cylinder. The increase in size of the explosion chamber thus effected is such that the relation of the volume of the stroke to the total volume always remains the same.

At first glance the construction of this motor seems somewhat complicated, and in fact the cost of construction must be considerably higher than for the ordinary gasoline motor.

In case, however, the motor is able to fulfill the claims made for it, this increased cost would be compensated for by dispensing with the transmission gear. Such a motor also should be very economical in fuel consumption, and the mechanical efficiency remains throughout the whole scale in constant ratio to the length of stroke. Another advantage of this motor is that the lateral pressure in action on the cylinder walls is reduced to a minimum. When the motor has been mounted in the car and the carbureter has been properly adjusted for the atmospheric condition, then every further variation of the number of revolutions or of the horsepower will be effected merely by the variation of the length of stroke; the throttle valve will then be used only when the motor with the shortest piston stroke develops more power or speed than the condition of the road demands at the moment.

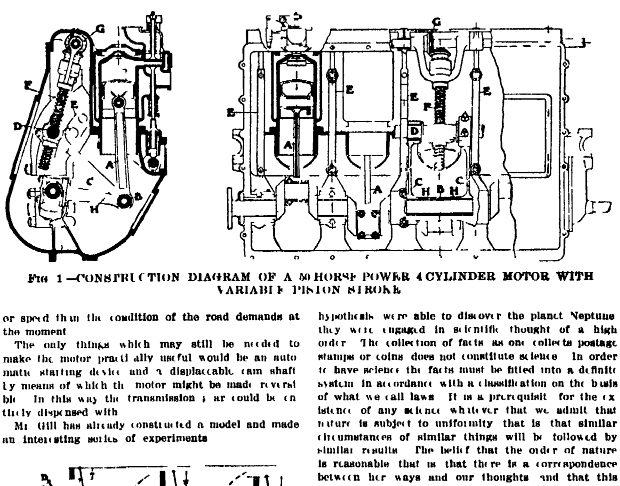


FIG 1.—CONSTRUCTION DIAGRAM OF A 50 HORSE POWER 4 CYLINDER MOTOR WITH VARIABLE PISTON STROKE.

The only things which may still be needed to make the motor practically useful would be an automatic starting device and a displaceable cam shaft by means of which the motor might be made reversible. In this way the transmission gear could be entirely dispensed with.

Mr. Gill has already constructed a model and made an interesting series of experiments.

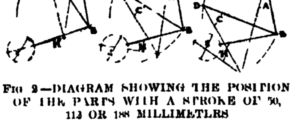


FIG 2.—DIAGRAM SHOWING THE POSITION OF THE PARTS WITH A STROKE OF 50, 112 OR 188 MILLIMETERS.

The cylinder diameter in this one-cylinder model (Fig 1) is 75 millimeters and the piston stroke can be varied between 25 and 88 millimeters. In the illustration the cover is removed so that the parts in operation are visible. In spite of its apparent complexity every part of the motor can be easily reached as soon as the cover, which forms a part of the crank case, is removed.

* * *

There are in the world, we are told by the late William Kingdon Clifford, three classes of persons: in the first place scientific thinkers; secondly, persons who are engaged in work upon what are called scientific subjects, but who in general do not, and are not expected to, think about these subjects in a scientific manner; and lastly those whose work and thoughts are unscientific. Scientific thought is not determined by the subject thought of. The subject of science is the universe, its limitations those of the human mind. When the captain of a ship finds its position by means of observations with the sextant, or when an engineer constructs a dynamo with the aid of a drawing and data known to be correct, he does not engage in scientific thought, although he makes use of experience previously collected. When the computer in the office of the Nautical Almanac computes an eclipse of the moon, foretelling it to a second of time several years before the event, he is not engaged in scientific thought, but is making use of technical skill. When, on the other hand, Adams and Leverrier, computing the positions of the planet Uranus, found them not verified in fact, but by the assumption of a new hypothesis were able to discover the planet Neptune, they were engaged in scientific thought of a high order. The collection of facts, as one collects postage stamps or coins, does not constitute science. In order to have science the facts must be fitted into a definite system in accordance with a classification on the basis of what we call laws. It is a prerequisite for the existence of any science whatever that we admit that nature is subject to uniformity, that is, that similar circumstances of similar things will be followed by similar results. The belief that the order of nature is reasonable, that is, that there is a correspondence between her ways and our thoughts, and that this correspondence can be found out, is scientific faith. The method of the inductive sciences, those that concern the facts of nature, is first to observe a class of seemingly related facts in order to find out what they have in common, then, if possible, to form some hypothesis as to their relation, then to compare the different cases with the hypothesis in order to see whether it is justified. When this process has been successfully carried out we are able to predict what will occur in given circumstances, although these circumstances have not occurred. This is what we mean by discovering a law of nature, namely, finding a common property of a class of phenomena such that under all circumstances the phenomena which will ensue can be described. That is what constitutes the difference between scientific and technical thought. Technical knowledge enables us to deal with cases that have occurred before, while scientific knowledge enables us to deal with what has not occurred before.

* * *

Mr Fisher, of the United States Geological Survey, says: "Few coals less than 14 inches thick are mined in a commercial way in the United States, but beds only 8 inches thick are mined commercially abroad. The first English Royal Commission on coal supplies in 1871 fixed 12 inches as the minimum workable thickness; however, many separate beds 8 and 10 inches thick are now worked commercially in England."

THE ORIGIN OF THE LUNAR CRATERS.*

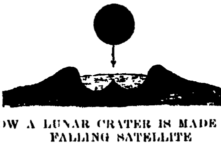
A CONSIDERATION OF THE IMPACT THEORY.

BY T. J. J. SEE.

IN a paper just published in the Astronomische Nachrichten No 4367 November 1909 the writer has treated of the problem of the obliquities of the planets, from the point of view of the capture theory, and has shown that Jupiter's small obliquity has been produced by the capture and absorption by the giant planet of vast quantities of satellites moving about the sun in planes nearly coinciding with the plane of the planet's orbit It is shown by calculation that if the mass of Saturn were increased by this process of capture till it became equal to that of Jupiter, the obliquity of Saturn would become as small as that of Jupiter, whence it is inferred that Jupiter's obliquity was once large and afterward gradually destroyed by the growth of his mass from the capture of satellites moving near the plane of his orbit This theory of the planetary obliquities is applied to the other planets of the solar system, and the facts are shown to be in good agreement with the theory

The origin of the lunar craters has long been a debated question in astronomy, but the traditional opinion dating from the time of Galileo is that they are volcanic; and this view is still held by leading investigators, such as Puiseux, of the Paris Observatory, and Prof Ebert, of Munich The theory that the lunar craters are volcanic seems to have originated with Hooke, 1667, and was generally held till the time of Humboldt. About the middle of the nineteenth century, however, several investigators, but especially Humboldt himself, and Schmidt, of Athens, became doubtful of the volcanic origin of these circular mountains, mainly because the inner parts of the craters were found to be depressions, with the central peaks below the average level of the lunar surface A tentative theory that the craters might be due to impact was outlined by Proctor in 1873 mentioned by Newcomb as a curiosity in 1878, and more fully worked out by the geologist G K Gilbert in 1892, but it has never been accepted either by geologists or astronomers

After a careful examination of all the evidence, I am satisfied that the impact theory is correct, and that the current volcanic theory is not well founded It happens that the impact theory brings the phenomena of the lunar surface into harmony with the capture theory of satellites and of the obliquities of the planets, and it will, therefore contribute to our understanding of the phenomena of the solar system If Jupiter's small obliquity has been produced by the capture and absorption of satellites, the evidence of such collisions, preserved by the indentations in the moon's face, becomes an important chain in the reasoning for establishing the processes involved in the formation of the planets and satellites The present discussion is restricted to a brief summary, but the reader who is interested in the subject should be referred to a paper on the cause of the variability of satellites recently communicated by the writer to the Astronomische Nachrichten, and to Gilbert's important paper of 1892 (Bulletin of the Philosophical Society of Washington, vol xii)



HOW A LUNAR CRATER IS MADE BY A FALLING SATELLITE

In connection with the formation of these craters, Capt A W Dodd U S N, has made several valuable suggestions resulting from his large experience in various kinds of target practice He tells me that when the resisting surface is not too hard, experiments with projectiles indicate that the crater will have about three times the diameter of the impinging shell Accordingly for the lunar surface with typical craters about sixty miles across the impinging satellites probably had a diameter of some twenty miles, about like the planet Eros or the smaller asteroids

If we wish to calculate the temperature of the falling mass after collision it is easy to approximate it by the formula for the mechanical equivalent of heat:

$$Q = \frac{1}{2}mv^2 = \frac{mv^2}{2 \times 9.81 \times 425} = \frac{v^2}{8339} \text{ calories.}$$

We find that for a mass of a kilogramme, moving with the parabolic velocity of the lunar surface, 2 37 kilometers per second, the result will be:

$$\frac{[2370]^2}{8339} = 673 \text{ calories.}$$

If the specific heat of a stony satellite be approximately 0 2, as in the case of terrestrial stone, the effect of the total heat of collision would be to raise it to a temperature of 3365 degrees centigrade But some heat is transferred to the moon's surface and a considerable part of the energy is expended in sinking a crater and throwing up a wall about it Notwithstanding this division of the energy, it is clear that many of the satellites colliding with the moon would be more or less melted and vaporized. As our moon has no atmosphere, the dust arising from such a conflagration would rapidly fall as metallic and lithic rain, and tend to cover up the ancient craters The condition of things thus predicted from mechanical theory is strikingly verified by observation of the lunar surface

INDENTATIONS IN A LEADEN DISK MADE BY BULLETS FIRED BY CAPT A W DODD, U. S N., AT MARE ISLAND

It is found that the impact theory explains the following facts:

1. Both large and small craters, and their superposition over one another, some being older and others newer, as the case may be

2 The frequent occurrence of small craters on the rims of large ones, where they would scarcely arise from eruptive causes

3. The existence of craters in perfectly smooth plains, as well as in rough and broken regions, and the unequal density of the craters in different parts of the lunar surface. Terrestrial volcanoes generally follow the mountain ranges along the seacoasts On the moon the craters are scattered indiscriminately, except that they are rare in maria, for reasons which will hereafter appear.

4 The greater steepness of the inner walls, and the great diameters of the larger craters, which could not well be explained by volcanic forces. If it be thought that more larger craters ought to be elliptical than are observed, it may be recalled that, even if the first contact with the moon produced such an outline, the impact of a large satellite would generate enough heat and underlying flow to force out the walls about symmetrically all around, and the final figure would be circular like the globular figure of the satellite. Thus craters which are, say, ten times as wide as they are deep, ought to be almost circular, while smaller craters would be more irregular and elliptical, as found by observation. This is because the forcing out of the material beneath small craters is less effective than in the case of large craters, and they retain more nearly their original shape of first contact.

5. The very flat-bottomed craters, noticed in such regions as Mare Nubium, are due to the filling up of deeper and more irregular craters with cosmical dust, or by melted material, which has assumed a level surface This has at length become so deep as to leave only the walls visible about a level central area, while the central peaks have been nearly or entirely covered up

6. In many cases the lunar photographs show that even the walls are practically covered up; for they can now be traced with difficulty, and merely as a faint outline The walls are covered up, especially in the so-called maria So far as one can see, two and only two, explanations of these so-called "ghost" craters are possible: 1 The deposit of cosmical dust from the heavens, and from the conflagrations arising in the impact of satellites 2 The partial melting down of the walls by the conflagrations, which produced the maria, so that only an outline of the original crater walls can be traced The fact that the "ghost" craters occur chiefly in the level maria supports the conflagration and melting hypothesis, and this certainly is one of the leading causes But since the earlier craters away from the maria also show the effects of age, as if tending to become obliterated by falling dust, this latter cause also is at work. Moreover, the two causes necessarily are related Together they explain the ageing of the craters in the rough regions far from the maria, as well as the buried or "ghost" craters in the maria themselves.

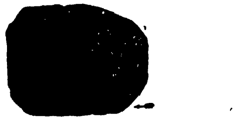
7 This shows that many craters have not only been obscured and partly blotted out by the falling dust, but also that a countless number of these objects have been permanently buried by the process of deposit and conflagration. The so-called seas are areas once made level by melting, in which few recent craters have been formed. The seas of the moon appear to be singularly level, and this can only point to terrible impacts at some time in the past, by which those whole areas were so fused that pretty much all inequalities of level disappeared. They have since been covered with a layer of cosmic dust, but have suffered relatively few large indentations. They generally appear dark, because the surface is nearly level, and the sun's light when reflected is but little scattered and seldom so directed that the beam from any considerable part of the surface passes near the eye of the observer

8 If this view be correct, it also indicates that the whole moon was formed by accretion, and that the surface never did experience true eruptive phenomena, such as we observe on the earth

9 The interior of the lunar craters is generally below the level of the surrounding normal surface, and this cannot well be explained except by impact. Volcanic eruptions could not well produce depressions of the crater basins

"The bottoms of many of the craters are very deeply depressed below the general surface of the moon, the internal depth being often twice or three times the external height" (Herschel, "Outlines of Astronomy," sec 430)

This remark of Sir John Herschel's shows that decided depression of the basins is common to all craters, both those with rims and those without It is almost impossible for volcanic forces to produce such a result One or two Hawaiian volcanoes are the only depressed craters on the earth, and they are recognized to be exceptions to the general rule of elevation characteristic of our planet.



HOW SOFT MUD IS INDENTED BY FALLING RAINDROPS.

10 It is evident that the craters have not been produced by the removal of material from the center and the piling of it up to make the surrounding walls; for in probably three-fourths of the cases, as Prof H. Ebert has shown, it is easily proved by calculation that the volume of the excavation exceeds the volume of the material contained in the wall This remarkable volume relationship would be explained if the matter beneath the crater were compressed by the force of impact, and only a part of it and of the falling satellite forced out to form the surrounding walls.

11 The shorter streaks radiating from such centers as Copernicus and Aristarchus are easily explained. It is sufficient to suppose that the collision was so forceful that matter was scattered far out in all directions, and perhaps heated to fusion in the process; yet, as the moon has no oxygen, it did not burn and blacken as meteoric stones do in falling on

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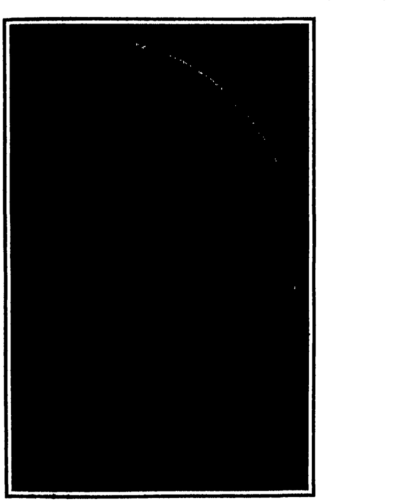
* Presented to the Astronomical Society of the Pacific November 28th 1909.

the earth, but simply took on a fused and glassy aspect which by reflection gives the brightness of the shorter streaks radiating from Tycho and its associates. This explanation was given by Mr. Wurdemann, of Washington, D. C., many years ago in a letter to Dr. B. A. Gould, but it seems to be but little known to astronomers.

12. The long rays from craters such as Tycho are similar optical effects of glassy material falling on walls of craters lying nearly in a straight line and radiating from this center. This is shown by the photographs. Any crater which had matter ejected from it radially in the process of formation will have a system of rays due to the effect of the sunlight on the higher elements of the surface traversed by the rays running from the crater as a center.

13. As the moon's force of gravity is feeble, the vapor and metallic and lithic rain due to impact might be carried hundreds of miles, and these streaks due to material falling on corrugations and ridges might extend out from the craters for a considerable distance and sometimes appear to be prolonged by coincidence with other crater walls or ridges.

14. The craters which are simple depressions without sensible walls are to be explained by the comparative looseness of the material of the moon's surface layers, which allows the mass to yield downward without throwing up much of a wall about the depression produced.



THE MOON SEVEN DAYS OLD SHOWING THE GREAT NUMBER OF CRATERS DOTTING THE SURFACE OF THE SATELLITE.

Photographed by Ritchey at Yerkes Observatory.

15. The clefts are paths cut by glancing satellites which thus leave a straight or curved line according to the nature of the surface and the resistance and rebound. Photographs confirm this origin of the clefts and show that they are not cracks but actual cuts sometimes more than a hundred miles in length.

16. Rills are cracks or offsets along walls of craters which often are more or less hidden by later deposits. They pursue in some cases an irregular course and often may be due to settlement of loose material as in landslides on the earth.

17. Changes in the aspects of a crater due to caving in, settlement, etc., are always possible, but to be entirely certain that the change is real the illumination has to be exactly the same at the two epochs, which is seldom possible. If the suspected changes are real, photography will eventually establish this fact.

18. The covering up of ancient cities on the earth is due to deposits of waste, rubbish and dust traceable to meteorological causes connected with the atmosphere, such as sand borne by the wind from the desert, etc. On the moon, however, there is no atmosphere sufficiently dense to carry dust, and it must therefore, be scattered by impacts and by direct descent from celestial space. The fact that the older craters are visibly covered up, is a tangible proof of the part played by cosmical dust in the course of ages.

19. The different degrees of obliteration shown by the various lunar craters is an impressive witness to the progressive falling of cosmical dust in a celestial world devoid of rain or other meteorological disturbance of any kind.

20. At zero degree centigrade the maximum molecular velocities of the atmospheric gases are found by Dr. Johnstone Stoney to be as follows: Oxygen, 1.8 miles; nitrogen, 2.0; water vapor, 2.5; helium, 5; hydrogen, 7.4. These values usually decrease with the fall of temperature, but the modification thus arising is not very considerable for small changes.

21. Now at the surface of the moon the parabolic velocity is 1.5 miles (2.41 kilometers, cf. A. N. 3992, p. 130), and therefore none of these atmospheric gases can be retained. For although we do not know the moon's temperature very accurately, it would seem that during the lunar night it must approach the absolute zero, while during the day it cannot well exceed the boiling point of water. Accordingly the above values are not sensibly altered by the admissible variations of temperature.

22. Observations on the refractions of stars occultated by the moon prove that if any sensible atmosphere exists at the lunar surface it does not exceed 1/5000th part of the density of the terrestrial atmosphere. We may therefore conclude that no sensible atmosphere has ever existed upon the moon, either before or since the capture by the earth, but that the vapors there arising have congealed into dust or constantly escaped into space.

23. The cosmical dust that falls upon the moon therefore encounters no atmospheric resistance, but plunges headlong against the lunar surface. Any vapor due to the force of collision quickly cools and is, if it condenses into solid particles, precipitated as dust, and nowhere amounts to a permanent cloud. If it remains true gas the molecules gradually escape into space.

24. If now we compare the lunar photographs with the accompanying imprints made by raindrops and by bullets fired into a leaden disk as a target, we shall notice the most remarkable similarity in the two effects. The raindrops, however, are all fluid and leave only saucer-shaped imprints and no central peaks, whereas the leaden bullets and stony satellites indenting the lunar surface would necessarily leave central peaks, in accordance with observations. Thus the moon's surface can be nothing but fragments of rock filled with finer dust, and it is evident that it has never been molten as a whole and has never shown true volcanic activity as known upon the earth.

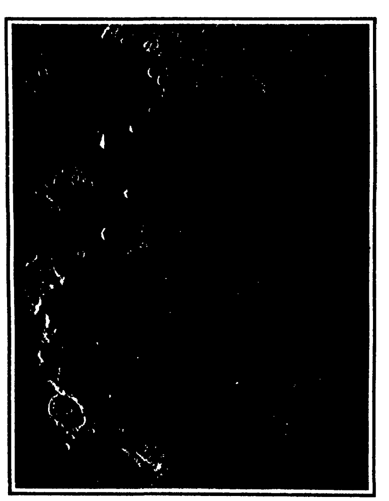
The last conclusion is confirmed from another point of view by an exact calculation given in A. N. 4053, p. 345, showing that the total gravitational heat of condensation of the matter of the moon would raise an equal mass of water through only 408 degrees centigrade. It is there pointed out (p. 348) that the development of such a small amount of heat in the course of long ages would not at any time give rise to a temperature that would produce fusion of rock. Even when radioactive substances are considered the conclusion is the same, namely, that in the slow and almost insensible development of the moon by accretion enough heat to produce general fusion could not have arisen.

Accordingly we may dismiss the old volcanic theory once for all as false and misleading, and may look upon our satellite as a shattered planet which presents to us the most lasting and convincing evidence of the processes of capture and accretion by which the heavenly bodies are formed.

The strength of the present argument regarding the origin of the lunar craters does not rest on one class of phenomena alone, but on several distinct classes of phenomena which are all harmonized among themselves and brought into accord with the necessary processes of planetary growth. Since worlds form in nature it follows that impacts will occur necessarily, and the moon's face shows the size of these masses by their imprints, which thus throw an unexpected light upon the state of the solar system in the past.

The variability of the satellites of Jupiter and Saturn, photometrically investigated by Guthnick in A. N. 4032 and A. N. 4038, indicates that they too have maria covering their surfaces due to collisions as in the case of the moon. For as observed from a distance the moon also would be variable according to the extent of the maria on the side toward the sun. Lastly, the mathematical argument regarding the capture of the satellites and the moon is confirmed by Schroeter's observations, 1789-1791, showing that the planet Venus rotates in 23 hours 21 minutes. For if Venus has that period the earth never could have rotated faster than at present, and the moon necessarily would be a captured planet. There is found also to be a theoretical reason why Venus ought to rotate faster than the earth, so that the capture of the moon is confirmed both by the observations of Venus and by mathematical theory, and the origin of the lunar craters by impact is a necessary corollary to the capture theory of satellites.

U. S. Naval Observatory, Mare Island, Cal.



MARE SERENITATIS, MARE TRANQUILLITATIS AND SURROUNDINGS SHOWING GHOST CRATERS BURIED BY CONFLAGRATION AND DEPOSIT.

Photographed by Ritchey at Yerkes Observatory.

In a patent recently issued to Dr. C. P. Steinmetz a description is given of a machine having interpoles without winding which operates sparklessly. The armature of the machine is of the closed-coil type provided with both a commutator and collector rings. The arrangement for operation is such that the m.m.f. of the current entering by way of the collector rings is greater than that leaving by way of the commutator, and the excess m.m.f. serves for exciting the interpoles to the extent required for sparkless operation. This result is obtained when the machine receives all of its power over the collector rings and delivers only a part over the commutator, the remainder being utilized mechanically at the pulley.

CHEMISTRY IN THE LAST FORTY YEARS.[*]

A BRIEF SKETCH OF ITS REMARKABLE DEVELOPMENT.

BY W. NERNST.

Although in principle physics and chemistry follow the same methods and look toward a common end, an end which, as Helmholtz has so aptly described it for physics, is "To assert by the logical forms of laws our intellectual mastery over nature at first a stranger to us," nevertheless the diversity of the problems and facilities has in practice necessitated a separation of the two branches. Consequently the energies of the physicist and chemist have been expended almost entirely on special problems in their own fields of research, and as a result a large boundary region between the two sciences remained neglected for a long time. Only in the period of time which this sketch covers has there been any lively interest in physical and theoretical chemistry.

No one will deny that, as far as any theoretical mastery of matter is concerned, physics has not for a long time made nor is even now making any advances. Why this can not be otherwise is easy to understand. The physicist often needs relatively only a very small amount of material to work on to derive immediately the fundamental theoretical laws of the subject which he is investigating. For example, it is only necessary to know the density of atmospheric air at a single temperature and a single pressure to develop physico-mathematically by the sole aid of the gas laws and the principles of the theory of heat the rule of sound vibration, and from that the fundamental principles of acoustics generally. How different and how much more difficult are the problems which confront the chemist when he attacks the study of atmospheric air, whether he attempts to determine its composition down to the last particle or whether he investigates the remarkable and complex equilibria which obtain at high temperatures.

Chemistry to-day can boast of a set of theoretical principles that do not suffer in comparison with those of physics. What a mass of experimental material is set forth in the table of atomic weights. What quantitative facts can the man of science draw forth from its figures, such as composition, specific heat, vapor density, lowering of the freezing point, and the like of innumerable substances. What can he not forecast by the aid of general analogy, in the way of physical and chemical properties of many other kinds when he calls to his aid that happy artifice, the periodic classification. The very fact that such an abundance of material has been brought together necessarily increases many times its importance after it has once been successfully classified.

The theory of the constitution of organic combinations furnishes a good example of this fact. In a short time, when the organic compounds gathered together in the new edition of Beilstein's handbook, which this society has under preparation, are published, we shall, I have been told by the editor, be confronted by more than a hundred thousand structural formulæ. It is by the aid of this theory of organic constitution that a great part of these combinations have been worked out, and it is only by its aid that it has been possible to describe and classify this stupendous amount of material. And if one finally considers all the information the initiated can read out of the structural formulæ and considers the mass of experimental data that often had to be obtained to establish even one of them, he realizes that in the quantity of experimental facts logically construed and classified, the doctrine of the constitution of organic combinations stands at the head of all theories that the human mind has conceived.

Another effect of the development of chemistry from the theoretical point of view is that already in a great many cases theoretical and experimental work can hardly be distinguished, so impregnated with theory have most of the branches of chemistry become. Consequently, it is my task to-day to give not a general view of the whole of theoretical chemistry, but merely of that part which may be called physical.

In the first part of this sketch the relations between physical properties and chemical constitution will be touched on, a subject which formed the principal field of research for physico-chemical work in the latter half of the period we are considering. The description of this work will be very much facilitated by an adherence to a systematic mode of classification, according to which the properties of substances are divided into three groups.

There is, first, the measurement of those accessible quantities which render possible the immediate deduction of the values for the molecular weights, and which may be briefly designated as molar properties. Among these, as Avogadro has shown, the vapor density deserves a place in the first rank, but it has been left for the new epoch, by the aid of the direct and indirect methods of measuring osmotic pressure, to throw an equal light on the molecular weight of dissolved substances. In the determination of the molecular weight of liquids the value of the temperature coefficient of surface tension has been of the greatest assistance, the heat of vaporization, the critical constants, the curves of vapor tension and a series of other values, also furnish more or less sure means to the same end.

All of these methods, with complete accord, lead to the conclusion that most substances, for instance the saturated hydrocarbons, possess the same molecular weight in the liquid state as in the gaseous condition, but that a number of substances, like the alcohols and especially water, are more or less highly polymerized in the liquid condition. But what is the degree of polymerization in each particular case? What equilibrium is established in these pure liquids? These interesting questions unfortunately still evade any exact or quantitative solution.

As the most important results of these new methods of determining molecular weights, especially of the osmotic method, we may mention first the ingenious theory of the existence of colloidal solutions as an intermediate stage between true solutions and mechanical suspensions, and then the more definite conception of the ion to which we shall return later.

A second series of properties are those designated under the name of additive properties. Any such property of a combination is the resultant sum of the properties of its constituents. To all appearances this is a very simple rule, but at the same time it is impossible to form any idea from it as to the size and structure of the molecule. Among those properties we may note, besides the molecular volumes of liquid organic compounds, molecular refraction, magnetic rotation, heat of combustion, and the critical coefficient.

A third series of properties depends not only on the nature of the atoms which exist in the molecule, but also on their arrangement in the molecular structure; accordingly they are designated constitutive properties. Thus the molecular refraction of hydocarbons depends not only on the number of hydrogen and carbon atoms present, but also on the existence or nonexistence of multiple bonds between the carbon atoms.

From this we derive a very important result; we may attribute to the double bond a determinate amount of refraction and take into account with a high degree of approximation the influence of its constitution, by a return to the additive method.

Frequently certain properties appear only with a particular grouping of atoms. In such case it is a qualitative rule of the highest value that, inversely, from the appearance of these properties we can predicate the existence of these definite forms of combination. The classic example of this type is afforded by the power of optical rotation in carbon compounds, which is dependent on the existence of one or more asymmetric carbon atoms (or similar asymmetric structures) in the molecule.

In the same way in these organic compounds one can discover from the appearance of color, or more exactly, from the appearance of certain characteristic absorption bands, as well as of fluorescence, the existence of particular groupings in the molecule. To this same category of properties belongs also, in the largest sense, electrolytic conductivity, which indicates the existence of free ions—that is to say, the combination of elements or radicles with electrons, and lastly, the appearance of the maximum value of 5/3 for the ratio of the specific heats of a gas is, according to the kinetic theory of gases, an indication of a monatomic state, a conclusion which, as is generally known, was first applied to a mercury vapor, and which in recent times has been of inestimable service in the determination of the atomic weights of the argon group of elements.

In the last analysis all these properties are probably constitutive also, and their interpretation as either purely molar or purely additive is only a more or less close approximation. Often, even in the regions which have already been cleared up to a great extent by the additive method, great difficulties have appeared upon a more careful investigation. I should like, therefore, all the more to place before you a special case where the theory seems to reach the greatest exactitude.

We have succeeded in reducing to exact terms the gas densities which for a long time afforded the only means of molecular weight determination. On account of the variation from the laws of perfect gases, which all actual gases show, it was natural that a method of approximation should be developed. In our epoch, however, we have learned with the help of van der Waals's equation, particularly by using compressibility, to reduce all gases to the ideal gaseous state and thence to deduce the exact relative values of molecular weights.

From these results, two ends have been attained. First, it has been proved that the most important of the theoretical laws that we possess, Avogadro's rule, appears to be an infinitely exact natural law; and second, a new method, purely physical, of determining atomic weights has been acquired which can stand comparison in exactness with the methods of analytical chemistry, but which is limited naturally to the cases where the density of compressibility of a chemically pure gas can be determined.

The problem, however, of reconciling experience and theory in the case of some other physical properties, as successfully as in this example, seems still far from solution. In general the exactness and consequently the reliability of theoretical treatment have been more striking in connection with the theory of corresponding states which we shall now take up.

In the theoretical consideration of natural processes, it has generally been considered necessary to take account only of very small variations of the system under observation, a variation of any extent caused so many complex accessory phenomena that it was possible for the mind's eye to follow them. Thus in theoretical physics we see the quintessence of nearly all theories represented by a differential equation, that is to say, by a mathematical formula which has to do with only infinitely small variations. The establishment of a differential equation (assuming, of course, that it can be solved) has a symptomatic significance in a science since its employment proves that the region of corresponding phenomena has been carefully considered. It was, however, by a rare and fortunate chance that the law of mass action was established in chemistry some forty years ago.

I recall very vividly the great surprise I experienced when for the first time a differential equation appeared to me in the study of the speed of reaction of the saponification of ethers, especially when I discovered how beautifully the integral of this equation was confirmed by the facts. How many inconsistencies, how many irregularities, and how many values depending on all sorts of conditions appear at first glance in chemical phenomena! Nevertheless the law of mass action shows us that, if we disregard the secondary phenomena of supersaturation and the like, if we maintain a constant temperature, and if we consider a chemically homogeneous system, we will have to deal with phenomena very clearly defined and calculable with mathematical precision.

The law of mass action furnishes at the same time the law for static and kinetic chemistry. It gives us the outlines not only for the experimental investigation of chemical equilibrium but for the speed of chemical reaction. Therefore I can cite as the most important result of the last forty years in this field the fact that not only are we in possession of the laws of chemical equilibrium and the speed of reaction, but above all we can classify a great many experimental facts as logically following the law of mass action. This law, as I have stated, is of the most general application, but experience shows us that general theories are not very profitable. Accurate results are never obtained except by fortunate specialization.

Organic chemistry, characterised by the inertia of the bonding of the carbon atom, furnishes a vast field for the application of kinetic chemistry, while the solutions of salts, acids, and bases which are characterized by the practically instantaneous nature of a certain category of chemical reactions offer an almost inexhaustible series of chemical equilibria.

Here, however, the law of electrolytic dissociation comes to our aid, a law derived, it is true, in principle from experiments on the electric conductibility of dilute saline solutions, but which was first put on a reliable experimental footing by the osmotic method of molecular weight determination.

The importance of this doctrine extends far beyond the field of chemistry proper. Briefly described, its application to chemical processes consists in the fact that it allows an exact application of the laws of static chemistry to characteristic aqueous solutions and through these to the reactions of ordinary analytic chemistry.

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[*] Address before the German Chemical Society at the celebration of the fortieth anniversary of the society November 11th 1907. Translated in the Smithsonian Institution's annual report from Berichte der Deutschen Chemischen Gesellschaft, Jahrgang xxxx., Heft 17.

The later refinement of this doctrine has resulted in a very detailed theory of equilibrium in dilute solutions, and in particular in the proof of the fact that when, for a certain solvent, the coefficients of dissociation and solubility of those electrically neutral molecules which are composed of several combined ions are known, the equilibrium in this solvent can be calculated; and if the coefficients of distribution are known, the equilibrium in any other solvent whatever can be derived with equal facility.

On account of the simplicity of the gaseous state we should expect that the law of mass action would be particularly profitable in reference to this phase. But it was found that at low temperatures the speeds of reactions, like many of the reactions of organic chemistry, were generally very small. At high temperatures, however, equilibrium was established as in ionic reactions almost instantaneously. But in this simple field there are, at the lower temperatures, difficultly controlled catalytic influences, and at the high temperatures inherent experimental difficulties place themselves in the way. It is nevertheless to be hoped that in this field of gaseous reactions which investigators are now eagerly attacking from different points, a wealth of material and a corresponding theoretical profit will soon be forthcoming.

In the application of thermodynamics to chemical phenomena lies another field where the methods of theoretical physics have been fruitful. There too, the first great step in advance was taken almost forty years ago. The work I allude to is that particularly important proof that the chemical law of mass action should be recognized as a direct application of thermodynamics, which is found in volume 2 of the transactions of the German Chemical Society.

Among the further results obtained in this way I should state that the aid of thermodynamics alone has made possible the close and exhaustive study of heterogeneous equilibria, particularly those where mixtures of given concentration (not only dilute solutions) enter into the equilibrium. For special cases of heterogeneous equilibria there comes into play the so-called "phase rule," which expresses in principle that in every case fixed (stable) equilibria correspond to given conditions of temperature, pressure, and concentration. This rule is therefore rather a reliable formula than a theory proper, and that is why from many sides we are warned not to exaggerate its value. More important from a theoretical standpoint is the demonstration in chemical compounds of two sorts of stability. One is the apparent stability which is characterized by the fact that its speed of decomposition is very slow (examples: Nitric oxide, hydrogen peroxide, and most organic compounds) and the other, the true stability, which is characterized by the fact that the equilibrium depends on a quantitative formation of the substance considered apart from its components.

Electrochemistry and photochemistry are governed by laws closely related to those of thermochemistry. Although the study of the latter of these two fields has presented, up to the present time, great difficulties in the way of theoretical investigation, Faraday's law, which establishes the proportion between chemical transformation and the quantity of electricity passed through a system in a given time and which thus makes possible the calculation of the electric energy necessary for a given change, has provided an accurate foundation for the application of thermodynamics to electrochemistry. Also, by continuing the special conception which gave rise to the theories of osmotic pressure and electrolytic dissociation, a simple conception of the electrochemical processes has been developed. It has at the same time become apparent that electrical forces unquestionably play a great part, not only in electrochemical phenomena, but also in many purely chemical reactions.

Thus we are brought to the problem of the nature of chemical forces. Although this question does not perhaps possess the fundamental importance that is often attributed to it, nevertheless it should be briefly considered. It can be treated here still more briefly because we are obliged to admit that during the period under consideration there has been no answer to this question which really tells us anything more than we can see with our own eyes. It seems reasonably certain that we should admit the existence, not only of electrical and therefore polar forces, but of nonpolar natural forces somewhat of the nature of Newtonian gravity. When fluorine and potassium unite to form a salt, the colossal affinity between the two elements depends at any rate in part on the affinity of the fluorine for negative electricity and of the potassium for positive electricity, but when we find in the ordinary nitrogen molecule two atoms of nitrogen united in a combination, perhaps of equal stability, it would appear that in the case of as complete an identity as presented by two atoms of nitrogen the action of polar forces should be entirely excluded. The fact that polar and nonpolar forces always act simultaneously in the production of chemical combinations is the principal reason why investigators have not yet been able to fathom the nature and the law of chemical forces, and is responsible for the fact that the investigations have not yet gotten away from a consideration of the balance of energy.

There is no need of entering here into that mooted question which has been brought up many times in physical chemistry, the question of the supremacy of the thermodynamic or the atomistic theory. This is perhaps nearly as important as determining whether Schiller or Goethe was the greater man, and should be answered in a like manner. We should rejoice in the possession of two resources so powerful and at the present time so indispensable for scientific thought. The chronicler should, however, make note of the fact that most of the modern results in the domain of physical chemistry have been obtained by a happy combination of thermodynamic methods with molecular theories, such as the creators of the modern theory of heat have followed in devoting most of their work to the development of the atomistic side, particularly of the kinetic theory.

Thermodynamics had its origin in the methods of mathematical physics. The atomic theory, on the contrary, owes its high state of perfection especially to chemical research. We should regard as a result of the latter the application of the atomic theory to the science of electricity which has begun to develop a chemical theory of electricity. There are many reasons for believing that the two forms of electricity are composed of almost infinitely small particles, each identical with the other, called "electrons." Consequently, free ions should be interpreted as combinations between the elements or radicles and the electrons, to which the laws of constant and multiple proportions apply and which likewise are governed by the theory of valence. We must limit, however, this brief indication of how the atomic theory by such a marvelous enlargement of its horizon, has put a number of physical and chemical processes in an entirely new light, and end with a few words on the radio-active emanations whose existence is made clear to us through the electron theory.

The effects of this radiation, according to the prevailing theory, are caused by the projection of electrons either in a free state or bound up with matter, and whose existence is most easily determined by the electroscope. These very recent researches have opened to us the new world of radio-active substances. For sensitiveness this method of research is often superior even to special analysis. As an example I may mention the fact that according to the calculations of a young investigator in this field, if a milligramme of radium C were divided among all the people living on the earth (about two thousand millions) each one of them would possess an amount sufficient to discharge five electroscopes, sufficient to enable him to study (with a sufficient experimental accuracy) the most important radio active properties of each element.

The extreme sensitiveness of this reagent for radio active substances has been the only factor which has permitted the discovery of several radio-active elements which had heretofore escaped notice because of their very small quantity or because of the brief period of their existence (in the sense of the hypothesis of atomic decomposition).

It is often easy to write history, but it is always more difficult to learn anything from the history after it is written. If I dare make a modest attempt in this direction, I should say perhaps that the chemist with such a mass of material to work on is destined in the future to prepare new compounds and to study the reactions of those already known as in the past, but that the methods of experimental and theoretical physics will be more and more called into requisition to supplement purely chemical research.

CONVERSE OF THE PRINCIPLE OF ARCHIMEDES.

By F. C. VAN DYCK, Rutgers College.

THE type of balance with bucket and plug employed for illustrating the principle of Archimedes may be used, in conjunction with a platform balance, for simultaneous illustration of the converse of that principle.

Referring to the figure, let the beams of both balances be made horizontal by counterpoises before the plug is immersed, the bucket being empty.

Then lower the plug into the vessel of water, step by step, balancing up each time by transferring water from the jar to the bucket. This process is perhaps familiar.

The following simple experiments are founded upon the converse of the principle of Archimedes.

No 1.

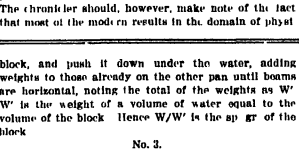
Upon one pan of an ordinary platform balance place a vessel containing water enough to submerge a body, the specific gravity of which is to be determined. Upon the other pan put any convenient counterpoise to make balance arms horizontal. A body denser than water, say a piece of iron, is suspended by a string and lowered into the water until just submerged. Then put weights on the counterpoise to make the beams horizontal, and note the sum of these weights as W. W is the weight of the water displaced by the iron. Next lower the iron until it rests on the bottom of the vessel containing the water, slacken the string, add weights to the other side until the beams are horizontal, and put the total of the weights as *W'*. *W'* is the weight of the iron "in air" (for the iron might lie on the pan outside of the vessel of water without altering W'). Hence the sp. gr. of the iron is W'/W.

No. 2.

As in No. 1 except that a body less dense than water is used; say a block of paraffined wood. Float it on the water and make the beams horizontal with weights summing up to W. W is, of course, the "weight in air" of the block. Stick a needle into the top of the block, and push it down under the water, adding weights to those already on the other pan until beams are horizontal, noting the total of the weights as W'. W' is the weight of a volume of water equal to the volume of the block. Hence W/W' is the sp. gr. of the block.

No. 3.

Balance, vessel of water, and counterbalance, as in Nos. 1 and 2. Suspend a large glass stopper or other body denser than water, by a string and submerge it in the water. Make the beams horizontal with weights summing up to W, which is the weight of a volume of water equal to the volume of the stopper. Then substitute for the vessel of water a vessel of another liquid, say kerosene, and counterbalance it. Submerge the stopper in the kerosene and make beams horizontal with weights amounting to W'. W' is the weight of a volume of kerosene equal to the volume of the stopper. Hence the sp. gr. of kerosene is W'/W.—School Science and Mathematics.



According to a contemporary, ferro-titanium rails were laid on October 7th, 1908, on Kessler's Curve, on the Cumberland division of the Baltimore & Ohio Railway. The curve carries heavy traffic, is of 9 deg., with 6¼-inch superelevation, and is laid with 90-pound rails. In order to reach a comparison, both plain Bessemer rails containing 0.55 per cent carbon and titanium rails containing 0.48 per cent carbon were laid. When the last diagram was taken on February 12th, 1909, the wear, according to a paper by Mr. Charles V. Slocum, before the Railway Club of Pittsburg, was 4.18 pounds per yard for the plain Bessemer and 1.45 pounds for the treated or titanium rails. The former "flowed" badly and showed excessive wear and the usual indications of segregation, while the titanium rails gave every indication that the steel was perfectly solid and homogeneous.

THE SIX HUNDREDTH ANNIVERSARY OF THE TURRET CLOCK.

THE following is reported from Milan. The six hundredth anniversary of the turret clock has passed unnoticed here. In the last days of December, 1309, the first turret clock was erected in Milan on the tower of the San Eustorgio. For many years this clock was considered a marvelous piece of work, and learned men and curious sightseers came from all parts to gaze upon the wonderful mechanism. From this time the art of clock making made rapid progress. As early as 1344 a turret clock was erected on the tower of the Signorina in Padua, showing the hours, the path of the sun, the orbits of the planets, the solar eclipses, the months and the annual festivals. The first alarm clock of which we have any record was mentioned in the Milan chronicles in 1430. The Councillor Andrea Alfiato was the owner of this clock, which however operated only at a fixed time, 7 in the morning. The alarm sounded, and at the same moment a small taper, automatically ignited, burst into flame.

[It seems rather doubtful, however, if Milan can really claim the distinction of being the birthplace of the tower clock, for according to the "Lexikon der Uhrmacherkunst" (Encyclopedia of Horology) one was installed in Westminster Hall, London, in 1288 and in Florence, Italy, in 1300, Milan being accorded third place.—ED.]

Correspondence.

RULE FOR SQUARING CERTAIN NUMBERS.

To the Editor of the SCIENTIFIC AMERICAN

In your February 12th issue I noticed "Curious Facts About Squares and Cubes" The latter part of that article is as follows "I can furnish you with a device if you desire it by means of which, the squares of the numbers 1 to 25 being given, the square can be written off in order *ad libitum* without any multiplication" Having read this, I noticed particularly, "The squares of the numbers 1 to 25 being given" I have seen a good many articles on the subject of curiosities about numbers etc but have never seen anyone publish an easy method for squaring numbers such as 15, 25, 35, 45, etc (You notice I leave out 20, 30, 40 etc as these are simple, as it is only the squaring of the tens)

The rule for squaring numbers such as I have given is as follows

First Square the unit as in 15 is 5 and $5^2=25$

Second—Square the tens which is 1 and $1^2=1$ and add itself =1 plus 1=2 The answer is therefore 225

In other words, 15 squared is easily found by squaring the units as above and the second operation by adding 1 to number, thus 1 plus 1=2 and 2×1=2

Thus 125 squared =15,625=5^2 and 12 plus 12 or 5^2 and 12×13 While it is hardly likely one would want to attempt any mental calculations of numbers, such as 126, 127, 128, etc, these are easily figured from the fact that we know, say in the case of 21, that we must have three figures in the answer Thus if we square $1^2=1$, and knowing that we must have three figures we put a 0 between the 2 plus 2=6 giving 601, and for each number that we are below the nearest number we can readily square, that is 25 In this case if we take the difference between 21 and 25 and multiplying the difference by 2, which = 4×2=8, and instead of considering the number as 21 we consider it as 20 and 20×8=160 and 601 minus 160=441, the square of 21 If the number was 29 we would then add instead of subtracting, then the operation would be 29^2 as above rule would be 681, then 20×8=160, 681 plus 160=841

Similarly with 129 would =15,681
120×8=960 960
16 641

or with 121=15,601 Note the 0
120×8= 960
14 641

In a similar way such numbers as 155, 255, etc, and 955 may be squared, not mentally, but by a "short hand" method I won't give any rule, but an example will show what is done:

```
955²=  95|5
       95|5
     ----|--
     9025|25
       95|
     ----|--
Answer  9120 25
```

Note the difference in operation as compared with such numbers as 15 25, etc

I have tried to condense the "rule" as much as possible and I think that it is clear as necessary, as there is nothing but elementary arithmetic used

If you think this may interest your readers, you are at liberty to publish it A. DELGADO

Schenectady, N. Y

ROSIN SOAPS.

A GERMAN paper states that Messrs W Daffert and J Woltbauer have conducted a series of experiments with soaps containing no rosin and such containing 10 and 30 per cent of it in order to determine their washing value The tests have shown that contrary to the opinion generally held, the resinous soaps have less value than those without rosin, all other things being equal The yield in washing diminishes with the content of rosin increasing In no case was rosin found to be favorable

Staybolts of electrolytic copper have given bad results in locomotives on Prussian railways in the last few years according to a statement by Mr Metzeltin in the Zeitschrift des Vereines Deutscher Ingenieure An unusual number of staybolt fractures occurred during recent years, in a period when electrolytic copper was adopted as material, in place of furnace copper As many of the fractures occurred on wide fire-boxes there was doubt as to whether the construction or the material was responsible Staybolts that broke were therefore collected for a period, and tested, of twenty three samples it was found that only two were of furnace copper and twenty one of electrolytic copper Of the electrolytic samples only one contained arsenic, while all the staybolts of furnace copper showed arsenic The Italian railways and the railways of the British colonies it is stated, specify a percentage of 0 15 to 0 55 per cent arsenic in copper

SCIENCE NOTES.

Prof. Neesen has made at Krupp's factory an experimental investigation of the course of projectiles In order to make it possible to follow the movement of the projectile during flight, he employed smoking projectiles by day and luminous projectiles at night and in the twilight The light was produced by a magnesium flame issuing laterally from the projectile Owing to the rotation of the projectile, the flame appeared intermittently By comparison of the duration of appearances and eclipses it was possible to estimate the extent of vibration, and to obtain other interesting data In some of the experiments projectiles fired from a mountain howitzer of three inches caliber, with an initial velocity of 1,000 feet per second and making 160 revolutions per second, were employed

The chief test of the success of a scientific hypothesis and of a train of reasoning therefrom is found in the ability to make predictions Of this probably the most striking example in all science is the law of gravitation All the observations of the last two hundred years have only resulted in confirming Newton's conclusion, while the accuracy of astronomical prediction exceeds that of any part of science Such is an example of scientific faith. Another famous example is Hamilton's famous discovery of conical refraction. On looking through a piece of Iceland spar at an object one sees it doubled The laws of this double refraction had been thoroughly described by Fresnel who related them to a certain geometrical surface invented by him By the study of the geometry of this surface, which was found to possess two singular points, Hamilton showed that on looking through the crystal in a certain direction at a point, one would see not two points but a whole continuous circle This experiment was made by Hamilton's friend Lloyd, who saw the circle, confirming in the most brilliant manner the wonderful imagination of Hamilton, who saw in his mind's eye what never yet man had seen

Of the natural sciences there are two fundamental ones, physics and biology Physics has to do with all the universe, in so far as it possesses energy, and exerts forces one part upon another, and in so far as it does not possess life Biology deals with all matter possessing this difficultly defined attribute, but so far as we know, even the phenomena of living matter are subject to the laws of physics. Every biologist will admit that life does not create energy, but merely directs it. Nevertheless, the question of vitality is to-day far beyond the explanation of the physicist The subdivisions of physics have been, for convenience only, set off as individual sciences, chiefly because the whole subject would be too large for the treatment of any individual scientist The most important part of physics is dynamics, which treats of the laws of motion, and the forces which are associated therewith Of this a great division is celestial mechanics, which, as we have seen in the cases of Galileo and Newton, contributed in great part to the inductive establishment of the laws of motion in general The remainder of astronomy is now catalogued as astrophysics and is dealt with by purely physical methods and instruments As a subdivision of astronomy may be reckoned geodesy, which deals with the form of the earth, deduced from astronomical measurements and from its gravitational attraction.

Chemistry is that part of physics which deals with the properties of substances that have individual characteristics by which they may be always distinguished, and which combine with each other in definite proportions Its methods are those of physics, its main instrument is the physical balance, and it is in recent years concentrating more attention upon those physical relations connected with temperature, pressure, and electrical relations, all of which are now found to yield to mathematical treatment in a manner until recently unsuspected The methods of physics and chemistry usually involve the controlling of certain of the circumstances under which phenomena occur, so that the changes in others may be more easily observed. This is usually done in a laboratory furnished with many means of controlling circumstances, for instance, temperature, pressure, electrical or magnetic state, so that the same circumstances may be reproduced again and again Meteorology, or as it is now somewhat grandiloquently called, cosmical physics, has to do with those phenomena of the atmosphere, the ocean, or the magnetic state of the earth, which are not controllable by man, and which cannot, therefore, be repeated at pleasure in the laboratory, but must be observed when and where they occur. The same applies to geology, which is the application of physics, chemistry and even biology, or any science whatever, to the earth, in relation to its physical constitution and its history. Geography deals with the face of the earth, and uses the results of geology to study the earth as fit to be the dwelling place for man. There remain the technical applications of physics in all kinds of engineering civil, mechanical, electrical, chemical or mining, involving the strength of materials, elasticity and the direction of the natural sources of energy to the purposes of man. All these applications of physics need, and are highly susceptible to, mathematical treatment, and for that reason they are the most perfectly developed of all the sciences.

TRADE NOTES AND FORMULÆ.

To Mend Leaking Lead Pipe While the Water is Running in It.—The leak is made wider and very quickly pieces of wheaten bread stuffed in, pushing it in in the direction whence the water comes. The hole can then be quickly closed by soldering a patch on it

Paint for White Leather Work.—Take 20 parts of zinc white, 20 parts of white bole and sufficient ultramarine, carefully mixed This powder to be incorporated by rubbing in a solution of 12 parts of white shellac in 40 parts of alcohol

Asbestos Paint (fireproof, for wooden structures)—30 parts ground asbestos, thoroughly mixed with 20 parts of clay, 30 parts of water, 10 parts borax, and 10 parts water glass warmed for a time, ground, and the color added.

Paint for Tin Roofs.—Take 30 parts linseed oil, 10 parts oil of turpentine, 14 parts English red, and 46 parts chalk. The coloring substance must be crushed fine, the mixture rubbed down in a paint mill, finally thinned with equal parts of oil of turpentine and linseed oil The tin must be free from rust.

Plastic Asbestos Mass (J. E G Merann).—Reduce asbestos to powder, from which, by mixing with water and stirring, a homogeneous mixture is prepared Then, adding more water, a paste is produced which is allowed to thicken by drying, until the mass acquires the desired plasticity. Objects formed from this mass, after being dried for a time, may finally be burned in a furnace.

Matt Black Varnish for Picture Frames and Furniture—Take 13 parts of shellac, 8 to 10 parts spirits of sal. ammoniac, 1 to 2 parts sal ammoniac, 0 25 part potash, 1 to 2 parts extract of logwood 0 75 to 1 part lamp black, 0 25 part boracic acid, 0.25 part blue vitriol and 75 parts water The varnish dries quickly and dead black with a velvety surface, adheres very durably on wood and will stand washing.

Flash Light Powder for Instantaneous Photographic Exposures.—Small cylindrical cartridge shells, made from the finest card, are filled with the flash light powder—13 8 parts anhydrous perchlorate of potash and 9 6 parts powdered magnesium thoroughly mixed with the help of a feather. On this is placed a pinch of igniting salt, 1 part milk sugar and 3 parts chlorate of potash, mixed, and over this a thin layer of gun cotton, the latter projecting at one point beyond the edge of the tissue paper covered cylinder. The cartridges are not expensive and can be burned in the hand

Grafting Wax.—In an iron pot melt over the fire, 100 parts of the finest asphalt, add 600 parts brown pitch until, with stirring, it is fluid then pour in 600 parts of melted yellow beeswax. The fire must not be too hot at this time When it is all well mixed, add 600 parts of thick turpentine, stir it well and pour into it 600 parts of refined tallow Lift it from the fire, stir until you begin to note that it is cooling and then drop in, stirring steadily, very carefully, because the mass will at once rise up, 250 to 500 parts of alcohol, according to the consistency we wish it to have

Barometer Paper.—To aqueous solution of sulphate of cobalt add solution of sulphocyanide of potassium as long as sulphate of potash is separated Allow the latter to settle, transfer it to a filter and wash it out with alcohol: use the fluid at once or concentrate it somewhat by evaporation (in the water bath at a low temperature) Brown: 1 part bromide of potassium, 1 part sulphate of copper, dissolved in 20 parts of water Yellowish Green. Dissolve in 20 parts of water 0.5 part of chromate of cobalt, 1 part nitric acid, 1 part common salt, slightly warmed Yellow: Equal parts common salt and chloride of cobalt, dissolved in 20 parts water. Pictures printed with these solutions change color according to the small or large quantity of moisture contained in the atmosphere

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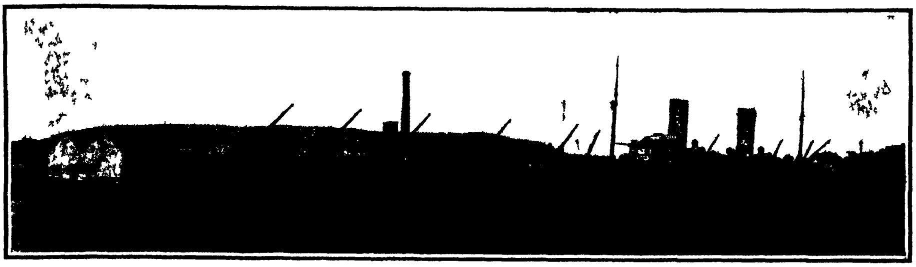
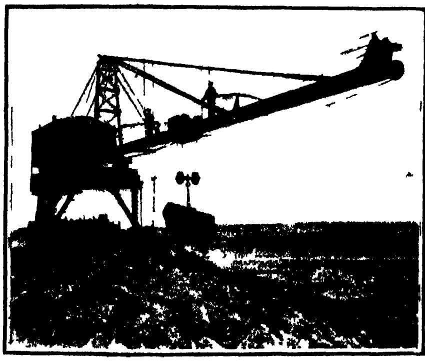


R. M. S. [illegible] LANIA IN BERTH AT WEST WHARF, KING'S [illegible], SWANSEA



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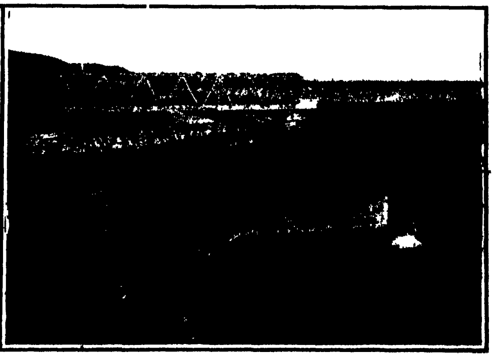

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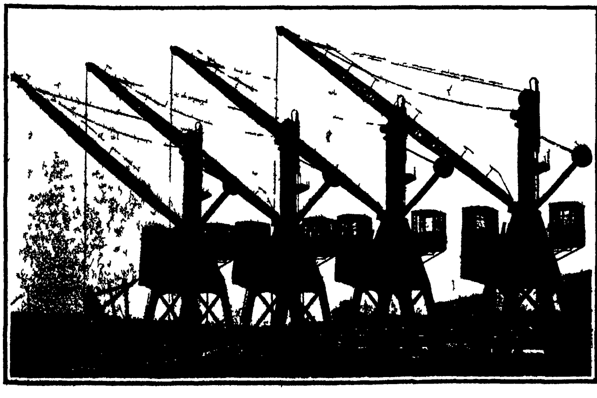
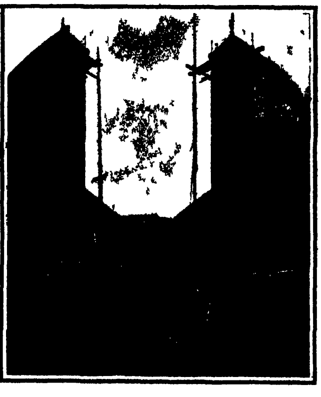


HYDRAULIC CRANES ON ONE OF THE WHARVES, KING'S DOCK.



THE LOCK FROM INNER END SHOWING GATE.

THE NEW KING'S DOCK AT SWANSEA.—[See page 21[illegible].]

POLICE DOGS.

CANINE DETECTIVES.

BY KARLERNST KNATZ.

Good detectives are very rare, and correspondingly expensive. Hence a police administration conducted with due regard to economy could scarcely afford to employ a veritable Sherlock Holmes, if he could be found. Ordinary detectives and policemen, on the other hand, cannot cope successfully with the highly developed and refined methods of the modern criminal. The police authorities, confronted with this dilemma, have lately employed, to a limited extent, an auxiliary possessed of instincts which take the place of detective genius. This auxiliary is the police dog, which, in Berlin at least, is giving almost daily proof of its fitness for detective and police work. The training and practice of these four-legged guardians of the peace are most interesting to witness.

One morning last summer, the writer was conducted by Police Major Klein, the organizer and commander of the canine police force of Berlin, to a public garden in the suburbs. Here we found assembled a number of the men of the corps, all selected from the general body of police with especial reference to their liking for dogs. On the grass lay the dogs attached to the northwestern police station—gaunt, sinewy animals with shrewd faces, of the German sheep dog breed. We took seats and the drill commenced. The dogs were required to give tongue at a signal and to lie still at assigned stations until the trainer, moving away from them, summoned them by a call or a whistle. Even when running at full speed they instantly stopped and lay down at the word of command. All of the dogs leaped a seven-foot fence with ease, even when they carried heavy objects in their mouths. The next test of obedience was the refusal of food. A dog was chained to a tree and ordered to guard some object, such as a bunch of keys. When I cautiously fished for the treasure with my cane, the dog rushed at me savagely, tugging at his chain, growling and gnashing his teeth. An appetizing piece of sausage that I had offered to distract the animal's attention, was regretfully sniffed at and then contemptuously ignored. The experiment was repeated with all the dogs, with the same result. Frack, the champion of the corps and the winner of many prizes, did not even turn his nose toward the sausage.

One of the police officers then beckoned to Grete, a bitch of remarkable beauty, and directed her, by a gesture, to search for something hidden in a clump of bushes at the back of the garden. Grete followed the indicated direction and soon returned with a two-mark piece in her mouth.

After witnessing these specimens of school work, we went out into the open fields, to see the dogs track and arrest supposed criminals. A crowd of curious onlookers had already collected. A young man, who subsequently proved an uncommonly tame and stupid malefactor, was enveloped in a heavy padded leather coat, which showed the marks of numerous dog bites, and directed to lay a trail by walking across a meadow, and then to conceal himself. Several other trails had been previously laid across the same field. A striking exhibition was then witnessed. Frack and another dog followed all of the trails, bringing back a handkerchief from one of them, and finally traced and discovered the criminal and sprang upon him, but released him instantly at their master's command. The sight made me shudder. These wise and faithful animals could become savage and ravenous beasts when duty demanded. They always seize their victim by the throat or the wrist, and a wild pistol shot only redoubles their zeal and ferocity. The poor fellow who impersonated the criminal was bathed in sweat, which was not due solely to his leather coat.

The exhibition closed with an aquatic performance in the neighboring canal. Here the leading part was taken by a dog which has actually rescued a number of persons from drowning and has brought many floating corpses to land. A puppet filled with cork was thrown into the canal. The dog swam out to it, seized it by one arm and drew it to shore, displaying astonishing skill, care and strength. In the water, as on land, the dogs surprised me by the promptitude and precision with which they advanced, retreated and turned to right or left, at the word of command.

The canine police corps of Berlin, already very efficient, is steadily improving, under the able guidance of Major Klein, who has given me his views on the functions and the training of police dogs in a personal letter, from which I quote the following:

"The fidelity and affection of the dog must be won, maintained and rewarded by kind and intelligent treatment. All dogs, even those of naturally obstinate disposition, are amenable to kindness. Many dogs are so sensitive that they cannot endure even a scolding, while a rash blow or violent imprecation may spoil them for a long period, if not forever. Obstinate and unimpressionable dogs may be treated with greater severity, after the trainer has clearly recognized their peculiarities. Such dogs must be taught that their willfulness and obstinacy are useless, and that man is their master, and the whip, applied at the right moment, is an efficient aid in inculcating this lesson."

In an article on police dogs, recently written by Dr. Th. Zell, this keen observer of animals gives a scientific explanation of the remarkable faculty of tracing persons and things by scent, upon which the efficiency of the dog, as an ally in the war against criminals, chiefly depends. Dr. Zell illustrates this faculty by comparing its absence with the defect of vision known as color blindness. A person who is color blind may see as clearly and sharply as a person with normal vision, but he cannot gather strawberries with conspicuous success, because the ripe and the green berries and the green leaves appear to him alike in color. A similar defect is exhibited by an ear that is unmusical, or tone deaf. The musical person distinguishes small differences in pitch and quality, which have no existence for the person who is tone deaf, although his acuteness of hearing, as shown by the ability to perceive very faint sounds, may equal or surpass that of the musician.

A color blind person cannot trace the course of a vessel or of a railway, as indicated on a chart or map by a red line, which is followed easily by a person of normal sight. If the dog, as we appear to be justified in assuming, attaches a definite mental image to each distinct odor, the animal's ability to trace the right trail through a labyrinth of other trails becomes explicable.

The following hints are abstracted from Major Klein's manual for the police dog service:

"The dog must be at once the assistant and the protector of the police officer, a trustworthy and respect-inspiring companion, giving to the solitary patrolman a sense of security and a moral support. He must be attached to his master alone, regarding other persons with suspicion and not allowing them to approach him. He should precede the patrolman to spy out the land. The keen scent, watchfulness and agility of the dog should facilitate the discovery of suspicious persons and conditions and save the policemen many useless steps.

"In the arrest and conveyance of prisoners, and in resisting attempts to free prisoners, and attacks upon officers, the dog should afford very valuable assistance, while in the pursuit of a criminal detected in the act of crime, the dog should, so to speak, extend the reach of the policeman's arm, by 'dogging' the footsteps of the fugitive, following his fresh tracks and finally holding him until the policeman arrives. The police dogs are also expected to assist in the rescue of persons in danger of drowning, and to follow persons whose manner indicates that they are contemplating suicide and give warning by 'baying.' In raids the dogs should hunt out concealed persons and betray them to the police."

In Paris, according to the newspapers, the police dog has already made his appearance on the theatrical stage, thus following in the footsteps of Sherlock Holmes, Lecoq and other real and fictitious human prototypes. This could never have occurred in a theater managed by Goethe, who left the theater in a rage when a dog was brought upon the stage.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Ueber Land und Meer.

QUANTITATIVE VS. QUALITATIVE THINKING.*

By R. W. RAYMOND.

IT was not so very long ago that the catalogue of a certain college announced the Rev. —— ——, D.D., as president, and professor of ancient and modern languages and history; of mental, moral and natural philosophy and applied science! A small and in some respects a ludicrous beginning—but it contained at least the aspiration, which was a prophecy, of the manifold and multiform training with which our best universities are now equipped and competent to furnish.

In the second place, this gathering emphasizes the underlying unity of all these specialties. Mining, metallurgical, civil, mechanical, electrical, chemical engineers, you are all engineers. Even the architects are engineers or else they are not fully accomplished as architects. You must, methinks, all possess something in common which makes you engineers, and which, as engineers, you are bound to make effective for the benefit of your generation.

I am not going to excite your ridicule or aid the somnolency of your digestion of such a feast as this, by offering you a complete, inclusive and exclusive definition of an engineer. Certainly, it means more than simply a man who runs an engine. Somewhere in the '70s of the last century, when the American Institute of Mining Engineers held its first meeting in Baltimore, a leading manufacturer of that city said to one of us, "If you have any influence with your brethren in that engineers' convention, I hope you will urge them not to order a strike. In these times, $2.50 a day is really all that we can afford to pay our engineers." Of course, he was told that ours was not a labor union, but a union of laborers, who never struck for high wages, but simply earned them and got them; and that our chief purpose was not to increase the wages, but to improve the work.

QUANTITATIVE THINKING ESSENTIAL.

While I do not propose to define the engineer, I beg to suggest one element which characterizes, I think, all true engineers. And I will use as a name for it a term borrowed from the laboratory. The engineer's thought and work are quantitative, not merely qualitative. Engineering lies at the base of the edifice of civilization, but the progress of civilization is often erroneously measured by mere inventions. Now inventions may sometimes be made and must always be perfected and utilized by engineers. But inventors who are nothing more fare badly, as they ought to.

How often we hear the accusation that the world has ill repaid the first propounder of an idea which in the hands of another has proved greatly profitable. But, in truth, it is not the happy thought about a thing, but the practical doing of the thing, that deserves reward. No doubt the first man, looking at the first bird, wanted to fly, and tried to fly, but the trouble was he couldn't fly. Should we now hunt up his heirs and pay them for the invention of their ancestor? His work was merely qualitative.

Once upon a time a pale, inspired inventor climbed up to my office and asked me to help him to go to Colorado. He had invented the idea of using electricity in mining and metallurgy; and he wanted to go to the Rocky Mountains, because at their summits electricity was so abundant. His notion was a qualitative one. Yet, no doubt, if he is still alive, he cherishes the notion that he has been robbed of the glory justly due to him for his bright idea.

INEFFICIENCY OF THE MERELY QUALITATIVE THINKER.

These qualitative enthusiasts grow more and more numerous every year, with the increase in half-educated practitioners of "applied science." And the old errors continuously crop out anew. After every big snowstorm, we have a number of qualitative proposals to remove the snow from our streets by thawing it with steam jets, and letting it run away of itself. What is still more remarkable, the editors of our leading newspapers gravely publish such communications, under the impression that there may be something in the notion, and that they had better not disparage it lest haply they be found fighting against science.

After the great blizzard a storekeeper in Brooklyn undertook to apply quantitatively this qualitative proposition. Having a 16-foot heap of snow opposite his store, and a cellar full of old boxes under it, he dug in the drift a chamber with a chimney, crammed this stove with the kindling wood from the cellar, lit the fire, and waited for the mountain to disappear in fervent heat. He, being a qualitative thinker, did not know the difference between temperature and heat units, or dream of the amount of work he was expecting his little fire to do. When he had burned all his wood he abandoned his faith in science.

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* Excerpts of an address given at the dinner of alumni of the Schools of Science and the School of Architecture of Columbia University. Republished here from the Engineering and Mining Journal.

I could multiply such illustrations indefinitely. But I may be permitted, in conclusion, to say generally and inoffensively, that qualitative thinking is one of the dangers of our day. Great popular manias, fads of special reform, exposures of public evils or hardships, appeals for governmental interference, all are, or are likely to be, merely qualitative. I think it was Thomas Jefferson who said, in substance, "A free people never loses its liberties by surrender to force. It gives them away in moments of enthusiasm."

It is the duty of engineers who have been trained to regard and handle things quantitatively, to contribute this needed element to the thought and action of their time. Let them make no haste to conclusions, let them count the cost, measure the means, weigh the sacrifices, appraise the gains and the losses. In a word, hold fast to the distinction between heat units and mere degrees of temperature.

THE "TYPICAL" MAN WHO DOES NOT EXIST.

THE COMPOSITE OF A HUMAN GROUP.

BY PROF. R. S. WOODWORTH

One of the most agreeable and satisfying experiences afforded by intellectual pursuits comes from the discovery of a clean-cut distinction between things which are superficially much alike. The esthetic value of such distinctions may even outweigh their intellectual value and lead to sharp lines and antitheses where the only difference that exists is one of degree. A favorite opportunity for this form of intellectual exercise and indulgence is afforded by the observation of groups of men. The type of man composing each group, that is what we should like to find; and we hear much of the "typical" scientist, the typical business man, the typical Englishman or Frenchman, the typical southerner, the typical Bostonian. The type of any group stands as a sort of ideal within the group, and, more or less caricatured, as the butt of the wit of other groups. There is one peculiar fact about these types: you may have to search long for an individual who can be taken as a fair example. And when you have at last found the typical individual, you may be led to ask by what right he stands as the type of the group, if he is a rarity amid it.

If we would scientifically determine the facts regarding a group of men, we should, no doubt, proceed to examine all the individuals in the group, or at least a fair and honest representation of them. The first fact that meets us when we proceed in this way is that the individuals differ from one another, so that no one can really be selected as representing the whole number. We do find, indeed, when we measure the stature or any other bodily fact, or when we test any native mental capacity, that the members of a natural group are disposed about an average, many of them lying near the average, and few lying far above or far below it, and we thus have the average as a scientific fact regarding the group. But the average does not generally coincide with the type, as previously conceived, nor do the averages of different groups differ so much as the so-called types differ. Moreover, the average is itself very inadequate, since it does not indicate the amount of variation that exists within the group—and this is one of the most important facts to be borne in mind in understanding any collection of individuals. It is specially important in comparing different groups of men, since the range of variation within either group is usually much greater than the difference between the averages of the groups. The groups overlap to such an extent that the majority of the individuals composing either group might perfectly well belong to the other.

No doubt statements like this will be readily accepted as far as concerns the different nations belonging to the same race. One could not seriously doubt that the nations of Europe, though they might differ slightly on the average, would so much overlap one another that, except for language and superficial mannerisms, the great majority of the members of one nation might be exchanged with a majority from another nation without altering the characteristics of either. But when we extend our view to all the peoples of the earth, the case would at first appear quite changed. Certainly whites and negroes do not overlap, to any extent, in color of skin, nor negroes and Chinamen in kinkiness of hair, nor Indians and Pygmies in stature. Such specialization of traits is, however, the exception. Whites and negroes, though differing markedly in complexion and hair, overlap very extensively in almost every other trait, as, for example, in stature. Even in brain weight, which would seem a trait of great importance in relation to intelligence and civilization, the overlapping is much more impressive than the difference; since while the brain of negroes averages perhaps two ounces lighter than the brain of Europeans, the range of variation within either race amounts to 25 ounces.

Our inveterate liking for types and sharp distinctions is apt to stay with us even after we have become scientific, and vitiate our use of statistics to such an extent that the average becomes a stumbling-block rather than an aid to knowledge. We desire, for example, to compare the brain weights of whites and of negroes. We weigh the brains of a sufficient number of each race—or let us at least assume the number to be sufficient. When our measurements are obtained and spread before us, they convey to the unaided eye no clear idea of a racial difference, so much do they overlap. If they should become jumbled together, we should never be able to separate the negroes from the whites by aid of brain weight. But now we cast up the average of each group, and find them to differ, and though the difference is small, we straightway seize on it as the important result and announce that the negro has a smaller brain than the white. We go a step further, and class the white as a large-brained race, the negro as a small-brained. Such transforming of differences of degree into differences of kind, and making antitheses between overlapping groups, partakes not a little of the ludicrous.

We seem to be confronted by a dilemma: for the group as a whole is too unwieldy to grasp, while the average, though convenient, is treacherous. What we should like is some picture or measure of the distribution of a given trait throughout the members of a group, and, fortunately, such measures and pictures can be had. Convenient and compact measures of variability are afforded by the science of statistics, and are of no less importance than the average. But still better, because closer to the actual facts, are graphic or tabular pictures of the distribution of the trait, showing the frequency with which it occurs in each degree. The distribution of a trait is for some purposes more important than the average. Let us suppose, for instance, that two groups were the same in their average mental ability, but that one group showed little variation, all of its members being much alike and of nearly the average intelligence, while the other group showed great variability, ranging between the extremes of idiocy and genius. It is evident that the two groups, though equal on the average, would be very unequal in dealing with a situation which demanded great mental ability. One master mind could supply ideas for the guidance of the group, and his value would far outweigh the load of simpletons which the group must carry.

If groups of men differ in average intelligence, this difference would have an influence on their effectiveness in mental work, and so, no doubt, on their advance in civilization. If groups differ in variability, this would probably have a still greater influence. There is one respect in which groups certainly do differ. They differ in size, and size is an important consideration, even from a purely biological point of view. The more numerous the individuals born into a group, the greater the absolute number of gifted individuals to be expected; and in some respects it is the absolute rather than the relative number of able men that counts. Besides this, the larger the group, the greater the chance of its producing a truly effective genius, just as, in the experiments of Burbank and other breeders, a vast number of plants are grown, in order to increase the chance of sports occurring.

One further consideration of this partly biological, partly statistical nature should be brought forward. When the individuals composing a group are measured or tested in several traits, it is found that those who rank high in one trait do not always rank high in others. On the whole, there is more correspondence than opposition; an individual who ranks well in one trait is rather apt to rank well in others. The correlation, as we say, is positive, but it is far from perfect. The individuals most gifted with ability in war are not altogether the same individuals who are ablest in government, or in art or literature, or in mechanical invention. This fact is not only of importance in reaching a just conception of a group, but it should be considered in comparing different groups. The circumstances surrounding a group call for certain special abilities, and bring to the fore the individuals possessing these abilities, leaving in comparative obscurity those gifted in other directions. Judging the group largely by its prominent individuals, we get the impression that the group is gifted in certain lines and deficient in others. A nation whose circumstances call for industrial expansion and the exploitation of natural resources gives prominence to those of its members who are successful in these pursuits, and leaves in obscurity many who have native capacity for military leadership. Should war come to such a community, time and bitter experience are often necessary before the leadership can be transferred from the previously eminent men to those obscure and often despised individuals who are capable of doing best service in the new direction. This lack of perfect correlation between various abilities makes it difficult to judge of the capacity of a group of men by casual observation, and we must accordingly discount largely the appearance of specialization of mental traits in different peoples.

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[*] Abstracted from the address of the vice-president and chairman of Section H, Anthropology and Psychology, of the American Association for the Advancement of Science.

A SCIENTIFIC CLASSIFICATION OF SMELLS

In a recent number of the Lancet a correspondent of that journal makes a plea for a scientific classification of smells just as there is a classification of colors and of sounds.

"The sense of smell," writes he, "is the function of the olfactory nerve, which also distinguishes the various flavors, and this may be the reason why so many persons cannot distinguish smell from taste. The four primary tastes are sweet, bitter, acid, and salt, and these have no effect on the olfactory nerve, hence analysis of this nerve does not delete the sweet, bitter, acid, or salty character of substance, but does of the flavoring agents. But paralysis of the glosso-pharyngeal and certain fibers of the fifth nerve destroys the sense of taste, but not flavor. Some of the senses are very fully classified, vision and hearing in particular, probably these give the greater pleasure to the great majority. We have primary and secondary colors, and therefore to describe a color as horrid would not be acceptable, although such passes muster for the smell."

How is a basis of a classification to be arrived at? Is such a classification in truth, possible? The writer thinks that it is, and he makes the following suggestions: "In the selection of odoriferous substances one recognizes the importance of choosing pure definite chemical bodies so as to avoid mixed smells, and that they should be capable of ready dilution, as strong odors not only quickly temporarily paralyze the olfactory nerve endings, but also irritate the fifth nerve. The concocted names of the primary odors should be easily adapted to affixes and prefixes. Having adopted the standard of odors and their names, I would suggest sets of them at the elementary schools to familiarize the children with them and their names, as is done at present in the case of colors. The foundation laid of an octave of smells, it would not be so difficult as hitherto to impart more definitely and intelligently the character of a smell to others in legal and medical cases. As a preliminary classification of the primary odors we might select such bodies as 1, ammonia, 2, sulphureted hydrogen; 3, bromine; 4, valerianic acid, 5, ether, 6, menthol; 7, camphor, 8, artificial musk, 9, nitro-benzol. Next we have to concoct a name for each of these odors apart from the names of the substances such as is done with colors. For example, red does not pertain to any particular substance, but is the quality of large numbers, and we can qualify the quality in various ways, such as reddish yellow and reddish brown, or yellowish red and brownish red. After settling the primary odors and names we could, I think, in the same manner describe the odors fairly well of a larger number of substances."

Creosoted piles driven in sea water in a dike at New Haven, Conn., about 1885, were examined a year ago. About 5 per cent of the piles in the channel arm and 25 per cent in the shore arm were in bad condition, due to rotting, beginning at the top in the center. The engineer suggests that deterioration might not have occurred if the tops had been protected.

ELECTRICITY AND LIGHT IN MODERN MEDICINE.

A NEW THERAPEUTIC AGENT.

BY DR. THEODOR SCHUELER.

A PROMINENT place among the physical agents employed in modern methods of therapeutics has been occupied for the past decade by light and especially by electric light which is used chiefly in the form of light baths and is furnished by arc and incandescent lamps separately or in combination. As a rule however the electric light bath may be regarded merely as an agreeable and elegant variety of hot bath and a substitute for the Roman Russian or hot air baths and the Turkish or steam bath. No peculiar therapeutic properties are now attributed to the rays of the electric arc or incandescent lamp.

The system of light baths which was invented by the late Prof Niels R Finsen of Copenhagen stands on a somewhat different footing and forms the basis of modern phototherapeutics and the inspiration of all subsequently devised phototherapeutic apparatus. The efficiency of the treatment of bacterial diseases of the skin especially lupus vulgaris or tuberculosis of the skin with concentrated ultraviolet radiations is now generally recognized. Finsen proved that this efficacy is due chiefly to two properties of the violet and ultraviolet rays their power to penetrate the skin and their destructive action on bacteria.

In Finsen's apparatus the radiation from an arc lamp is filtered through water which absorbs most of the ultrared or heat rays and is concentrated upon the skin by lenses of quartz which does not like glass absorb much of the ultraviolet radiation and which aids in absorbing the ultrared rays. The apparatus is made in two forms a large model for use in hospitals and a smaller one known as the Finsen Rheyn lamp for the use of physicians in private practice. The latter consists of a 20 ampere direct current arc lamp a concentrator and a compressor. The apparatus is so mounted on an iron stand that it can be turned in any direction. The concentrator is a wide metal tube containing a number of quartz lenses through which a current of cold water flows continuously. The compressor is attached to the end of the concentrator and consists of a short brass cylinder closed at each end with a plate of quartz and filled with the circulating cold water. The terminal quartz plate is pressed against the diseased portion of the skin which is cooled by the stream of cold water so thoroughly that a very concentrated beam of light, possessing great heating power can be employed without danger. A still more important function of the compressor is to drive the blood from the skin and thus to make the skin more permeable by the rays. The treatment is applied for at least 45 minutes at a time. The management of the apparatus is not easy but the method provides a sure cure for lupus and leaves no visible scars. In Copenhagen a great institution the Finsen Institute has been established which receives from the Danish government an annual subsidy of 2 000 crowns (about $6 700) in return for the free treatment of poor lupus patients.

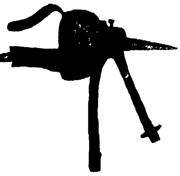
The Finsen treatment is the best form of phototherapeutics for lupus and all other deeply seated diseases of the skin but other forms of apparatus

THE DESSAUER APPARATUS FOR APPLYING ROENTGEN RAYS

have been devised for the treatment of eczema baldness erysipelas and other diseases of superficial character. Within the last few years many arc lamps with metallic electrodes have been invented which emit a far larger proportion of violet and ultraviolet rays than the ordinary carbon arc lamp produces. The largest proportion of these rays is emitted by the mercury vapor lamp invented by Cooper Hewitt which is used largely in photography. Dr Kuech substituted for the glass tube of the Cooper Hewitt lamp a tube of quartz and thus greatly increased the emission of violet and ultraviolet rays which as was observed above are absorbed very rapidly by glass but very little by quartz. The quartz mercury vapor lamp was again modified by Kromayer for therapeutic use. The Kromayer lamp contains a tube of fused quartz two-thirds of an inch in diameter having the form of an inverted V. The air is completely removed from the tube the ends of which form mercury cups which constitute the electrodes and are connected to the lighting wires. This luminous tube is inclosed in a globe which is also made of fused quartz and the globe is inclosed in a watertight case of nickeled brass provided with a quartz window which can be pressed directly against the skin of the patient. The space between the quartz globe and its metal case is filled with cold water which enters continuously through a tube at the bottom of the case and flows out through a tube at the top. The lamp is ignited by tipping it and thus causing a thin stream of mercury to flow along the tube and establish connection between the electrodes. When the lamp is righted and the thread of mercury is broken a powerful luminous arc is formed in the mercury vapor which fills the tube. Local treatment with or without pressure can be applied very conveniently with this lamp but great care must be taken to avoid burning the skin. This treatment is efficacious in all forms of eczema carbuncles and ulcers of the legs and various parts of the skin and mucous membranes but especially in "wet" eczema and in circular baldness. Treatment with pressure is employed especially in lupus and burns. In the opinion of the writer and other physicians experienced in photo-therapeutics, however the quartz window of the Kromayer lamp should not be pressed directly upon the skin for various reasons and especially because the window cannot be thoroughly sterilized after each application. I have therefore attached to the window a water cooled metal tube with which are fitted blocks and closed tubes of quartz of the sizes and shapes most suitable for application to the external skin and the mucous membranes which line the various cavities of the body.

FINSEN RHEYN LAMP

A ROENTGEN TUBE

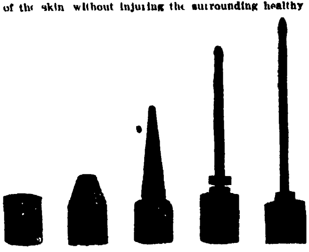


KROMAYER LAMP WITH QUARTZ EXTENSION

Another new and very valuable therapeutic agent is furnished by the Roentgen rays which have exerted a powerful influence on every branch of medicine. For the production of these rays electric currents of high tension and small quantity or strength are required. The reader who is not well versed in electrical theory may obtain an idea of the meaning of these terms (pretty nearly as good an idea as the electrician possesses by the way) by picturing the electric current as a current of water flowing through a pipe. The electric tension or electromotive force corresponds to the pressure or "head" of the water and the strength of the current in each case is the quantity of water or of electricity that passes in a given time. The unit of tension is called a volt and the unit of current strength is called an ampere. When an electric current of very high voltage such as is produced by an electrical machine or a Ruhmkorff induction coil is interrupted about 2 000 times a minute by suitable mechanism and the interrupted current is caused to flow from one metallic electrode to another in a so called vacuum tube (which is really a glass tube from which nearly but not quite all the air has been pumped) that part of the glass wall which is directly opposite the negative electrode or cathode (which is flat or slightly concave) glows with a greenish light and emits outside the tube the invisible rays which are known as Roentgen or X rays. These rays possess a remarkable power of penetrating all substances to a degree dependent on the density of the substance. They also affect photographic plates and cause fluorescent substances to glow and they produce a peculiar stimulation when they fall on the skin.

If the hand is placed on a photographic plate which is inclosed in a plate-holder and Roentgen rays are thrown on it from above a photograph showing every bone of the hand is produced in a few seconds. It is even possible to produce an X ray photograph of the ribs and the lungs in a single second. In this way diagnosis can often be greatly facilitated. A bullet a needle or the fracture of a bone can be quickly and accurately located tuberculous spots in the lungs can be discovered and with especially good apparatus the presence of a stone in the kidney can be detected. For all of these purposes hard Roentgen tubes are employed i e tubes containing only an infinitesimal quantity of air or a very high vacuum. Soft tubes which contain a little more air are used in the application of Roentgen rays to the skin for the cure of disease. The rays destroy diseased cells and hence if they are applied promptly and persistently they remove and heal morbid growths of various kinds. If the rays produced by soft Roentgen tubes are applied for a very long time their destructive action extends to the healthy tissue. Hence soft tubes can be used with advantage only in the treatment of superficial growths and diseases such as the various forms of acute and chronic eczema psoriasis scaldhead warts etc. I never apply soft tube rays longer than ten minutes or oftener than three times a week and I have never observed any injurious effect in the ten years during which I have employed Roentgen rays. Sometimes in spite of every precaution the hair of a small part of the head is destroyed but a new and much more luxuriant growth always appears within a few months.

Quite recently hard Roentgen tubes have been employed in the treatment of deep seated affections of the skin without injuring the surrounding healthy tissue, even when the application is continued for an hour or longer. The method of using hard tubes was devised by Prof Poelhes, and has been improved by Dessauer who employs very "hard" tubes, in which the vacuum is so high that an electromotive force of 120 000 volts is required to force a current through



QUARTZ BLOCKS AND TUBES FOR APPLYING ULTRAVIOLET RAYS, WITH PRESSURE, TO VARIOUS PARTS OF THE BODY them. This high voltage is produced by specially designed induction coils, which are immersed in oil in order to secure perfect insulation. The coil is operated by an alternating current, in connection with a Goetze rectifier and a Wehnelt interrupter. The induced current passes through two or more extremely "hard" Roentgen tubes, which are placed from 20 to 40 inches distant from the patient, who is protected from injurious radiations by the interposition of a large pane of window glass. The rays can be applied in this manner for two or three hours, without producing any injury to the healthy tissue. Very gratifying results have been obtained with Dessauer's apparatus. I employ this method in the treatment of sarcoma (malignant tumors), cancerous growths in their earliest stages, goitre, Basedow's disease, tumors of the lymph glands and pernicious anemia. True cancer, if well developed, requires the knife, but after the operation I apply the Roentgen rays to the wound and the entire body, in order to destroy lurking germs and prevent a relapse.—Die Gartenlaube.

SOLAR VORTICES AND MAGNETIC FIELDS.—I.*

RECENT STUDY OF THE SUN.

BY PROF. GEORGE E. HALE.

The spectroheliograph, which tells us of the existence of solar vortices, is a natural outcome of the application of the spectroscope in astronomy, where Englishmen were foremost among the pioneers. The detection of a magnetic field within these vortices followed directly from Zeeman's beautiful discovery of the influence of magnetism on radiation—a logical extension of the earlier work of Faraday, and from the classic investigations of Crookes and Thomson on the nature of electricity.

It is customary to distinguish sharply between the observational and experimental sciences, including astronomy in the former. In physics or chemistry the investigator has the immense advantage of being able to control the conditions under which his observations are made. The astronomer, on the other hand, must be content to observe the phenomena presented to him by the heavenly bodies, and interpret them as best he may. I wish to emphasize the fact, however, that the distinction between these two methods of research is not so fundamental as it may at first sight appear. In 1860 a laboratory, in which experiments were conducted for the interpretation of astronomical observations, was established by Sir William Huggins on Upper Tulse Hill. The advantage of imitating celestial phenomena under laboratory conditions was thus appreciated half a century ago. I shall indicate later how important a part such a laboratory plays in the work of the Mount Wilson Solar Observatory. I shall also show that in other ways the astronomer may advantageously follow the physicist, particularly in the choice of observational methods and in the design of instruments of research.

Sun-spots were discovered as soon as Galileo and his contemporaries directed their little telescopes to the sun. In fact, ancient Chinese records indicate that spots of exceptional size had been detected by the naked eye many centuries before. Long after their discovery, the most diverse views were held as to the nature of sun-spots. Sir William Herschel mentioned the uncertainty which had existed prior to his time, remarking that the spots had been variously described as solid bodies revolving about the sun, very near its surface; the smoke of volcanoes, smoke floating on a liquid surface; clouds in the solar atmosphere, the summits of solar mountains, uncovered from time to time by the ebb and flow of a fiery liquid, etc. In Herschel's own view the spots are to be considered as the opaque body of the sun seen through openings in the luminous atmosphere which envelops it. Indeed, he considered that the sun should be regarded as the primary planet of our system, and even suggested the probability that it is inhabited. "Whatever fanciful poets might say, in making the sun the abode of blessed spirits, or angry moralists devise, in pointing it out as a fit place for the punishment of the wicked, it does not appear that they had any other foundation for their assertions than mere opinion and vague surmise, but now I think myself authorized, upon astronomical principles, to propose the sun as an inhabitable world, and am persuaded that the foregoing observations, with the conclusions I have drawn from them, are fully sufficient to answer every objection that may be made against it."*

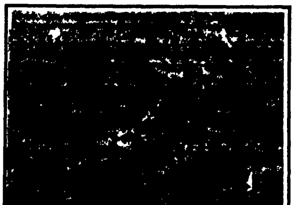


FIG. 3.—SAME REGION OF THE SUN, SHOWING THE HYDROGEN ($H\alpha$) FLOCCULI.

1908 April 30, 5h 08m P. M. Pacific standard time.

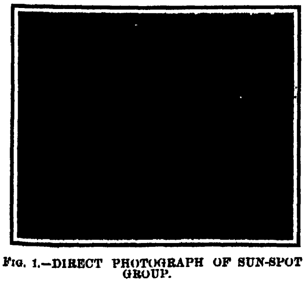


FIG. 1.—DIRECT PHOTOGRAPH OF SUN-SPOT GROUP.

1908, April 30, 6h 20m A. M. Pacific standard time.

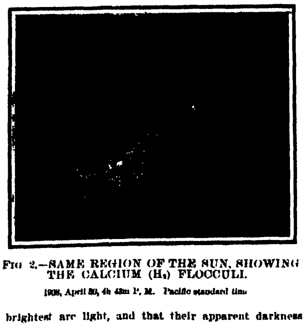


FIG. 2.—SAME REGION OF THE SUN, SHOWING THE CALCIUM (H_2) FLOCCULI.

1908, April 30, 4h 43m P. M. Pacific standard time.

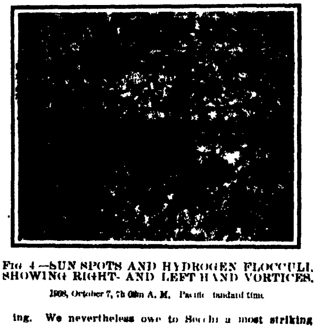


FIG. 4.—SUN SPOTS AND HYDROGEN FLOCCULI, SHOWING RIGHT- AND LEFT-HAND VORTICES.

1908, October 7, 7h 08m A. M. Pacific standard time.

Sir John Herschel did not abandon the idea of an opaque solar globe, but suggested that hurricanes or tornadoes might account for the piercing of the two strata of luminous matter which ordinarily conceal this globe. "Such processes cannot be unaccompanied by vorticose motions, which, left to themselves, die away by degrees and dissipate—with this peculiarity, that their lower portions come to rest more speedily than their upper, by reason of the greater resistance below, as well as the remoteness from the point of action, which lies in a higher region, so that their center (as seen in our water-spouts, which are nothing but small tornadoes) appears to retreat upward. Now, this agrees perfectly with that which is observed during the obliteration of the solar spots, which appear as if filled in by the collapse of their sides, the penumbra closing in upon the spot, and disappearing after it."

We now know that sun-spots are brighter than the brightest arc light, and that their apparent darkness is merely the result of the contrast with the intensely brilliant surface of the photosphere. We also know that the sun is a gaseous globe, attaining a temperature of about 6000 deg. at its surface, and perhaps millions of degrees at its center. If we examine a large-scale photograph of a sun-spot we see, that it consists of a dark central region, called the umbra, and a surrounding area, decidedly less dark, called the penumbra. The structure of a spot, as this admirable photograph by Janssen shows, is granular, like that of the photosphere. In the penumbra these granulations seem to group themselves more or less radially, as though under the influence of some force directed toward or away from the umbra. Unfortunately, direct photographs of the sun have not yet attained such perfection as to show the most minute details of sun-spots. To appreciate these, we must have recourse to the exquisite drawings of Langley, the truthful quality of which is recognized by every astronomer who has observed sun-spots under favorable conditions. We shall see that the characteristic structure represented by these drawings is repeated, on a far greater scale, in the higher regions of the solar atmosphere disclosed on recent spectroheliograph plates.

Since the time of Sir John Herschel many astronomers have proposed vortex theories of sun-spots. One of the first of these is the theory of Faye, who supposed the whirling motion to be the direct result of the peculiar law of the sun's rotation. This law was discovered by Carrington, who found from observations of spots near the equator that the sun completes a rotation in about twenty-five days, while the motion of spots at a latitude of 40 deg. indicated the time of rotation to be nearly two days longer. Thus, as the rotation period increases toward the poles, the photosphere at the northern and southern boundaries of a sun-spot must move at different velocities (assuming the law of the sun's rotation to be the same as that of the spots). This difference in velocity would tend to set up whirling motions, clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Sun-spots, in Faye's opinion, are the visible evidences of such whirls.

This theory has had many supporters, but it is now generally agreed that the difference in the rotational velocity of adjoining regions of the photosphere is not nearly sufficient to account for the observed phenomena. Secchi, one of the most assiduous observers of solar phenomena, was strongly opposed to Faye's theory. He pointed out that about 6 per cent of the spots he observed gave some evidence of cyclonic action, but in the vast majority of cases such forms as Faye's theory seemed to demand were lacking. We nevertheless owe to Secchi a most striking drawing of a sun-spot vortex.

When the spectroheliograph was first systematically applied to solar research in 1892, many rival theories of sun-spots occupied the field. Since the function of this instrument is to photograph the phenomena of the invisible solar atmosphere, it might be hoped that the results would throw much light on the nature of sun-spots. For many years, however, this hope was not realized. The first monochromatic images of the sun were made with the K line of calcium. If we compare such an image with a direct photograph of the sun, made in the ordinary way, we see that the sun-spots are surrounded and frequently covered by vast clouds of luminous calcium vapor. These attain elevations of several thousand miles above the sun's surface but they must not be confused with the prominences, which ascend to much higher elevations. When observed at the sun's limb the bright calcium flocculi, as these luminous clouds are called, are so low, in comparison with the prominences, that they can hardly be detected as elevations. Thus our knowledge of the calcium flocculi must be derived mainly from the study of spectroheliograph plates, which show them in projection on the disk. I must not omit to mention however, that the calcium vapor rises to the highest parts of the prominences, and that this higher and cooler vapor frequently indicates its presence on spectroheliograph plates in the phenomena of dark flocculi. These are relatively inconspicuous, however, and need not be discussed here.*

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* Discourse delivered at the Royal Institution.

* William Herschel "On the Nature and Construction of the Sun and Fixed Stars," p. 20.

It soon appeared that the average photograph of bright calcium flocculi could not be counted upon to indicate the existence of definite streams or currents in the solar atmosphere. In 1903 the hydrogen flocculi were photographed for the first time. By comparing these flocculi with the corresponding calcium flocculi we see that, in general, dark regions on the hydrogen image agree approximately in form with bright regions on the calcium image. This might appear to indicate that hydrogen is absent in the regions where calcium is most abundant. An investigation of the question, however, does not lead to this conclusion. Dark hydrogen flocculi seem to mark those regions on the sun's disk where hydrogen is present as an absorbing medium, which reduces the intensity of the light coming through it from below. In certain areas, where the temperature is higher or the condition of radiation otherwise different, the hydrogen flocculi are bright. In many cases eruptions are in progress at these points but in others the difference in brightness is apparently not the direct result of eruptive action.

The hydrogen flocculi thus photographed with the lines $H\beta$, $H\gamma$, or $H\delta$, differ in many respects from the calcium flocculi. Not only do they usually appear dark, where the calcium flocculi are bright, their forms exhibit striking peculiarities, which are absent or much less conspicuous in the case of calcium. The appearance of the calcium flocculi resembles that of floating cumulus clouds in our own atmosphere, their capricious changes in form reveal the operation of no simple law. But the hydrogen flocculi, on the contrary, exhibit a definiteness of structure in striking contrast to this appearance. Some of the photographs strongly remind us of the distribution of iron filings in a magnetic field and suggest that some unknown force is in operation.

Such was the condition of the subject when the red $H\alpha$ line of hydrogen was first applied to the photography of the flocculi on Mount Wilson in March, 1908. The calcium and hydrogen flocculi had been studied for several years, and much had been learned as to their nature and their motions. It had been found, for example, that the calcium flocculi observe the same law of rotation that governs the motions of sun-spots, while the hydrogen flocculi apparently follow a different law, in which the decrease in the angular rotational velocity from the equator toward the poles is much less marked. The latter result is in harmony with the investigations of Adams, whose accurate measures of the approach and recession of the hydrogen at the eastern and western limbs of the sun offer but little evidence of equatorial acceleration on the part of this gas. For this and other reasons it had been concluded that the hydrogen shown in such photographs reaches a higher level than the vapors of the bright *(H)* calcium flocculi. The region of the atmosphere previously explored with the spectroheliograph was nevertheless confined (except in the case of eruptions and dark calcium flocculi) to a comparatively low level lying within a few thousand miles of the photosphere. What might be expected if a still higher region could be satisfactorily photographed in projection on the disk?

The red line of hydrogen offered the means of disclosing the phenomena of this higher atmosphere. As it may not immediately appear why different lines, caused by the radiation of the same gas should not give precisely similar photographs a brief reference to the aspect of a prominence in the red and blue hydrogen lines may be advantageous. Here are two photographs of the same prominence, seen in elevation at the sun's limb, one made with $H\alpha$ the other with $H\delta$. As the red line is very bright even in the highest regions the photograph taken with its aid shows the entire prominence. $H\delta$ on the other hand is relatively weak at the higher levels, and consequently only the lower and brighter parts of the prominence are well recorded when this line is used. If, now, we suppose ourselves immediately above such a prominence, at a point where we observe it in projection against the disk, it is evident that the character of the hydrogen lines must depend upon their brightness at different levels. As we know that, speaking generally, absorption is proportional to radiation, the amount of light absorbed in the upper part of the prominence will be much greater for $H\alpha$ than for $H\delta$. Hence the average level represented by the absorption of $H\alpha$ will be higher than the average level represented by $H\delta$, since the higher gases play a more important part in the production of the former line. We may therefore expect that photographs of the sun's disk, taken with the light of $H\alpha$, will show the dark areas corresponding to absorption in the prominences much more clearly than photographs taken with $H\delta$. Moreover, since $H\alpha$ is stronger than $H\delta$ in the upper chromosphere, in regions where no prominences are present, the average level represented by this line will, in general, be higher than that represented by $H\delta$. A comparison of two photographs of the sun's disk, made with the lines in question, will suffice to make this clear. This enormous group of prominences, stretching for several hundred thousand miles across the sun, is much more clearly indicated by $H\alpha$ than by $H\delta$. In general, the hydrogen flocculi are stronger and more distinct when photographed with $H\alpha$ and there are some regions which appear bright with $H\alpha$ and dark with $H\delta$. This latter peculiarity probably has an important bearing upon the similar behavior of hydrogen in certain stars and nebulæ but a discussion of this question cannot be undertaken here.

The first of the $H\alpha$ photographs gave strong hopes of a substantial advance in our knowledge of the solar atmosphere. The sharpness and comparatively strong contrast of these flocculi, and the evidences of definite structure and clearly defined stream lines which they revealed, were highly encouraging. The work was begun during the disturbed weather of the rainy season, when the definition of the solar image is never of the best. On April 30th, 1908, the first photographs were secured under the fine atmospheric conditions which prevail in the dry season. A direct photograph (Fig. 1) shows a small insignificant group of sun-spots, which would not seem without other indications, to merit special attention. The next photograph (Fig. 2) shows that an enormous calcium flocculus occupied this region of the sun but its form was in no wise remarkable and afforded no evidence of the phenomena brought to light by the $H\alpha$ photograph. The structure recorded with the aid of the latter line (Fig. 3) recalls Langley's sun-spot drawings, and suggests the operation of some great force related to the sun-spot group. The same cyclonic structure had been less satisfactorily recorded on the previous day, but a comparison of the two photographs failed to indicate such changes as motion along the apparent stream lines might be supposed to produce.

The close of the rainy season now permitted an active study of the $H\alpha$ flocculi to be undertaken. Many photographs were made daily, and the almost constant association of apparent cyclonic storms or vortices with sun-spots became evident. During several months of the year in California an unbroken succession of clear days can be counted upon so that the changes of a given vortex can be followed without interruption. The cyclonic storms were found to be of two principal types, the first associated with groups of spots and represented in such photographs as those of April 30th and September 2d, the second associated with single spots and resembling a simple vortex, as illustrated in the photographs of September 9th and October 7th, 1908 (Fig. 4). The appearance of these simple vortices is such as to indicate rotation in a clockwise direction in the southern hemisphere, and in a counter-clockwise direction in the northern hemisphere (assuming the direction of motion to be inward toward the spot). However, this cannot be taken as a general law, corresponding to the law of terrestrial cyclones. Indeed, many instances have been found of closely adjoining spots, in the same hemisphere and frequently in the same spot group, having magnetic fields of opposite polarity, produced by vortices rotating in opposite directions.

In some cases, at least, these vortices seem to exercise a powerful attraction on the surrounding gases, as a series of photographs taken on June 3rd, 1908, illustrates. A long dark hydrogen prominence, first photographed in elevation at the sun's limb on May 28th, had advanced half way across the solar disk. It lay at the outer boundary of a well-defined vortex, centered on a sun-spot. This spot had been gradually separating into two parts, and on June 3rd the separation was complete. The first photograph of a series of nine was made on this day at 4h 58m. Several successive photographs indicated no appreciable change, but one taken at 5h 07m showed that the prominence was developing an extension toward the spot. At 5h. 14m, this had assumed the appearance illustrated in the next photograph, and eight minutes later, when the last photograph of this series was taken, the extension had almost reached the spot. It will be seen that it divided into two parts, which indicates that each umbra was a center of attraction. The average velocity of the motion toward the spot was more than 100 km. per second. Later photographs, made on the following days, show a ring of bright hydrogen surrounding the spots, suggesting that the comparatively cool hydrogen carried down into the spots was re-heated and returned to the surface, after escaping from the lower end of the vortex. We thus seem to be observing some of the phenomena of an actual vortex in the sun, but it must not be supposed that cases of this kind are common. In many instances the hydrogen flocculi do not appear to move rapidly toward or away from spots, but undergo changes of intensity, as though the physical condition of the gas were constantly changing, but before proceeding further with a discussion of these sun-spot vortices, let us turn to another phase of the subject, which will afford much new information indispensable for this purpose.

We are all familiar with the effect produced by passing an electric current through a wire helix. The lines of force of the resulting magnetic field are parallel to the axis of the helix, and its intensity is determined by the diameter of the helix, the number of turns of wire, and the strength of the current. We also know, from Rowland's experiment, that the rapid revolution of an electrically charged body will produce a magnetic field. Thus, if a sufficient number of electrically charged particles were set into rapid revolution by the solar vortices, a magnetic field should result. What warrant have we for assuming the existence of charged particles in the sun, and how could such a field be detected?

Let me pass rapidly in review a series of phenomena with which you are all familiar. Sir William Crookes showed in this lecture room, so long ago as 1879 that the negative pole of a vacuum tube sends out a stream of particles capable of setting a light windmill in rotation and deviated from their straight path when under the influence of a magnetic field. He has kindly consented to show the same tube again to-night, you now see the effect upon the screen. The recent work of Sir Joseph Thomson and others has proved that these are negatively charged particles called "corpuscles" or "electrons," and that their mass is about 1/1700 of the mass of an atom of hydrogen. Moreover, Thomson has shown that at low pressures these corpuscles are given off from a hot wire or from the carbon filament of an incandescent lamp. He has also demonstrated that this property of emitting corpuscles at high temperature is common to carbon and to metals, whether in the solid or in the vaporous condition. Thus we have warrant for the belief that the sun, composed of just such elements as constitute the earth, must emit great numbers of these corpuscles. As Thomson has estimated that the rate of emission of a carbon filament at its highest point of incandescence may amount to a current equal to several amperes per square centimeter of surface, we can hardly be mistaken in assuming the existence of still more powerful currents in the sun. The emission of negatively charged particles implies the emission of positively charged particles, but in laboratory experiments, because of unequal rates of diffusion or other causes, charges of one sign are always found to be in excess. We thus have reason to believe that powerful magnetic fields may result from the revolution of these particles in the solar vortices.

In seeking a means of detecting such fields, let us first recall Faraday's discovery of the effect of magnetism on light, made at the Royal Institution in 1846. This discovery relates to the rotation of the plane of polarization of light when passed through a plate of dense glass in a strong magnetic field. Although Faraday, in what was said to be his last experiment, endeavored to detect the effect of magnetism on the lines of the spectrum, he failed because the apparatus then available was not sufficiently powerful. In 1896 Prof. Zeeman examined with a large spectroscope the two yellow lines emitted by sodium vapor in a flame between the poles of a powerful magnet. Observing in the direction of the lines of force, he saw that the sodium lines widened when the magnet was excited. Subsequently, with more powerful apparatus, he found that a single line, when observed under the above conditions, is split into two components by a magnetic field. The distance between the two components is a measure of the strength of the field; but the most characteristic quality of these double lines, which distinguishes them from double lines produced by any other known means, is the fact that the light of the two components is circularly polarized in opposite directions. If, then, we encounter a double line in the spectrum of any substance, and suspect it to be due to a magnetic field, we must apply the test for circular polarization.

The simplest means of testing for circularly polarized light is to transform it into plane polarized light by passing it through a quarter-wave plate or a Fresnel rhomb. In the case of a Zeeman doublet, we would then have issuing from the rhomb the light of the two components polarized in planes at right angles to one another. A Nicol prism, standing at a certain angle, will transmit one of these plane polarized beams and cut off the other. Turning the Nicol through 90 deg. will cause the component previously cut off to be transmitted, and the other to be stopped.

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* Eruptive prominences are also recorded on the disk as bright flocculi.

Consider a sun-spot at the center of the solar disk, and suppose it to be produced by a vortex, the axis of which lies on the line passing from the eye of the observer *through the spot to the center of the sun.* In these circumstances, if a strong magnetic field is produced by the vortex, the spectral lines due to vapors lying within this field should be widened or transformed into doublets. Moreover, the light of the components of these doublets should be circularly polarized in opposite directions. This would be true if the spot vapors were emitting bright lines, identical in character with those emitted by a radiating vapor between the poles of a magnet. The experiments of Zeeman, Cotton, Konig, and others, show, however, that dark lines, produced by the absorption of the spot vapors, should behave precisely in the same way as bright lines.

The spectrum of a sun-spot was observed for the first time by Lockyer in 1866. He found that many of the lines of the solar spectrum were widened where they crossed the spot, and the observation of these widened lines has been carried on systematically by many observers ever since. Conspicuous among these observers was Young, whose last observations were made with a powerful grating spectroscope attached to the 23-inch Princeton refractor. This instrument showed that some of the spot lines are close doublets. Dr. Walter M. Mitchell, who at first worked in conjunction with Prof. Young and later by himself, gave special attention to these double lines, which he found to be particularly numerous at the red end of the spectrum. He called them "reversals," and the existing evidence favored the view that they were produced by the radiation of a hotter layer of vapors overlying the spot, which would give rise to a narrow bright line at the center of the widened dark line.

True reversals of this kind actually seem to occur in the case of *H* and *K* and other lines in the spot spectrum, and it was therefore natural that Mitchell should attribute the similar phenomena of the spot doublets to a similar cause. It was generally supposed that the widening of the dark lines was due *to the increased density of the spot vapors.* The diverse character of the lines in the sun-spot spectrum is well illustrated by this drawing, which is due to Mitchell. In addition to the ordinary widened and "reversed" lines we find cases where a dark central line is accompanied by wings, others in which lines are thinned or completely obliterated, etc.

(To be continued.)

SCIENTIFIC GUESSWORK.

THE VALUE OF LOOSE METHODS.

In scientific research, as in less ambitious affairs, the possession of a good imagination is often of the utmost value. We may go even further than this, and say that on occasion it is the only means available for advancing our knowledge into unexplored regions. For in all pioneer work there comes a time when the strictly logical reasoning of the textbooks fails to carry the investigator forward, and he must turn to his imagination to supply some missing step or to suggest a fresh pathway for exploration. The tentative nature characteristic of scientific deductive reasoning in so many branches of inquiry is alone sufficient testimony to the extent which the imaginative powers play in building up our knowledge. The practical application of this mental quality is seen at almost every turning among the steps that lead to all great discoveries and inventions. There are few instances in which a closely reasoned sequence of ideas has been employed in the evolution of outstanding achievements, there are equally few in which the authors of these advances have not owed a large measure of their success to the happy inspiration of their imaginations. But there is a limit to such methods as to every other, and care must be taken to guard against an overindulgence in them. Work, otherwise excellent, can be easily spoiled by a too ready departure from the regions of orthodox procedure.

The tediously gathered results of investigation have before now been rendered barren of any real good to the scientific world by the looseness of deduction employed afterward. However much trouble we may take in order to secure accuracy in our observations, they are useless until they have been carefully correlated among themselves and with the results obtained by others. Yet it is not uncommon to find some of our best and most careful workers making a loose and even careless analysis of the results of their experiments. Thus assumptions are made which, their nature being afterward forgotten, are taken as truths, arguments are drawn from slender hypotheses and theories built all too readily on purely fanciful grounds. It is imagination run rioting and degenerated into mere guesswork. By such means science can never advance, and may in time incur ridicule rather than respect by becoming the playground of fancy. No more pointed illustration of this tendency could be obtained than is afforded occasionally by the graphical results of experimental work. Relying, as it would seem, mainly on intuition, a curve will be drawn through the plotted points, and it will then be asserted that the result represents the law sought. Inspection all too frequently shows that not only is the "law" thus indicated honored in the breach, but is greatly dishonored in the observance. What sort of mental jugglery the authors indulge in so that they may become convinced of the correctness of their views, or how they can impose them on others, it is difficult to guess. For in the cases referred to many curves besides that given might be drawn and with equal justification. The curve shown has frequently no more claim to be considered as that which would be obtained if experimental errors were absent, than a host of others. Yet two curves possessing the same degree of probability may have vastly different shapes and a consequently great influence on any theory or practical work founded on them. As an example of this rash jumping to a conclusion, we would instance certain experiments carried out a short time ago on wind pressures. Here the plotted points were joined up with a smooth curve which was thought to represent best the true state of affairs. Near the origin the divergence of some of the points from the curve thus drawn was seen to be excessive, but it was concluded that this was due to unusually great experimental errors. Some time later further work on the same lines yielded results which showed that at this region the curve had points of inflection and should dip down so as to include the discredited points of the former experiments. Thus the entire theory built on the first results had to be modified, and a new phenomenon was discovered, which, although in evidence in the earlier work, had been passed over because of the wrong assumptions made. At other times we have seen experimenters boldly drawing in curves when the number of points on the diagram was wholly insufficient to warrant any curve whatever being given. A striking example of this was published recently. Several points were clustered in two opposite corners of the figure, a group lay in the middle, and a curve approaching a parabola in shape—but it might just as readily have been a quadratrix or a caustic—was drawn through the points, virtually only three in number. A superfluity of points may likewise lead to guesswork of this nature. We need only refer to experiments carried out on the strength of columns to show a typical example of this class. In certain charts giving the experimental results of an investigation on this subject, the curve threads its path through a "milky way" of points. Some are far above it, some are far below it, and those which fall on it are insignificant in number compared with those that do not. It cannot be pretended, then, that the curve represents the results of practical research, for the diagram itself shows that the column is much more likely to fail when loaded to some other stress than that indicated by the curve.

It is difficult to suggest any general means whereby this tendency to guesswork may be eradicated or even modified. A certain amount of it is, and always will be necessary in all scientific research work. The great difficulty is to place a limit to its indulgence, to determine at what point it ceases to be justifiable and becomes a hindrance in the pathway of advancing knowledge. Each particular example, it is plain, should be judged on its own faults. Yet we may state as a general proposition, covering the most flagrant examples, that excessive departure from strict reasoning is frequently due to the influence which the worker's former beliefs exert on his mind when he is analyzing the results of his research. Many experimental investigations would, we believe, be greatly benefited by an honest attempt on the part of their authors to get rid of preconceived ideas. For it is seldom that an experimenter commences to work with a perfectly open mind as to how the results should turn out. When these are found, as they frequently are, to be somewhat different from the results forecast, there are few workers who are sufficiently strong minded to believe firmly in their own figures. After the experiments are over the results will be modified and "corrected" so as to bring them more into line with what the investigator thinks they should be. By tampering in this fashion with his figures he may readily obscure certain features of the subject investigated which are really inherent in it and not, as he thinks, accidentally present. In the same way it is easy for him to read into his results features that have no practical existence and thus found a totally erroneous theory. Where the conditions of the experiment are thoroughly understood we are, no doubt, justified in altering our figures to a limited extent in a direction coincident with that in which our reason tells us truth must lie. This is the true use of imagination. But where these conditions are imperfectly known, where there are no previous experimental facts to guide our reason, we must, to avoid mere guessing, abide closely by our own results until such time as further work will enable us to view them in a fuller light.—The Engineer.

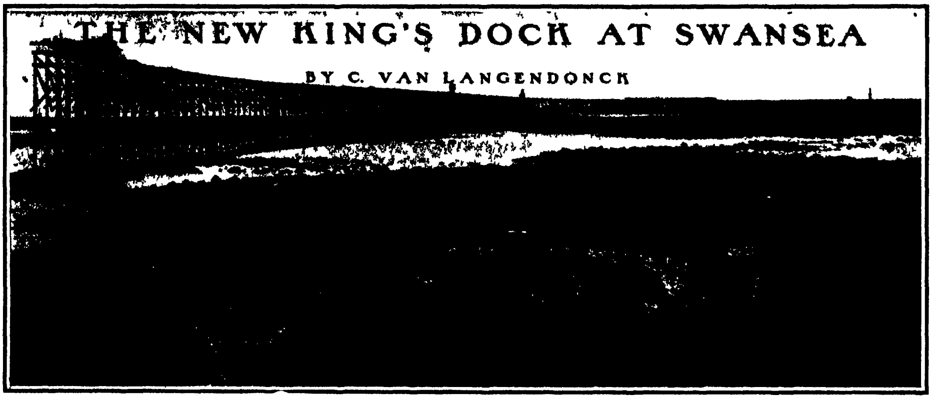
EXOTIC DAINTIES.

An astonishing variety of opinions, in regard to what is fit to eat and what is especially delicious, is found among the different races of mankind. Articles which appear strange and repugnant to Europeans appear as dainties at Chinese and Japanese banquets, and some African tribesmen greedily devour grasshoppers and even termites and scorpions. The writer recently held the empty but still fragrant tin of his last German "hand cheese" under the nose of a Samoan, who was astounded by this evidence of the white man's fondness for foul-smelling articles of food. Yet many strange and horrible things are eaten in Samoa. If a fisherman feels hungry he pulls the fine spines from a freshly caught fish and devours all the rest. The flesh of the holothuria, or sea cucumber, is eaten, although it is gritty with carbonate of lime, but the tough leathery skin and the contents of the almost hollow body are rejected. The forests are infested by the larvæ of a gigantic stag beetle, caterpillars four inches in length and as big as a man's thumb, which feed on fallen and decaying trees. The natives dig out the caterpillars with knives and hatchets and eat them alive, with the exception of the head. A favorite and particularly repulsive dish, the eating of which is now prohibited by the authorities, is rotten breadfruit. The crop of breadfruit is so great that it cannot be consumed in the fresh state, so the breadfruit is buried in pits lined with banana leaves until it has become quite putrid and is then eaten. It must be admitted, however, that the Samoan bill of fare contains many things which are keenly relished by European palates.

A new type of diving dress, especially adapted to deep-water operations such as cylinder sinking and submarine salvage, has been devised by an English engineer, Mr. Henry Parker, of Tring Hill, Hertfordshire. This engineer has been identified with many difficult cylinder sinking undertakings in connection with bridges, notably the River Murray bridge in Australia, where cylinders were bedded in granite 96 feet below water, and the Forth bridge. The diving plant which he has now evolved is based upon the experience gained in the foregoing tasks. The diving dress is almost as flexible as the ordinary attire, but enables the diver to carry out his work in 200 feet of water with greater ease than at present attends his movements at a depth of 80 feet. Moreover, it is doubly safe in moving among rocks or the interiors of sunken ships, whether in deep or shallow water. The diver can come up from a depth of 200 feet to the surface, and lie on the water for a time as the pressure is reduced as desired, without incurring any injury and with less risk than is at present the case. The cost of the dress does not exceed that of the ordinary outfit by more than 25 per cent. The usual pump and all existing lighting and speaking connections can be attached to the helmet, as in the present installation.

THE NEW KING'S DOCK AT SWANSEA

BY C. VAN LANGENDONCK



THE TIMBER GANTRY FOR MAKING SEA EMBANKMENT

Although the port of Swansea is placed on the banks of the river Tawe it may for all practical purposes be regarded entirely as an artificial port the discharge of the river being trifling as compared with the volume of tidal water ebbing and flowing between the pierheads. The history of the Swansea port works may be said to have commenced about 1792 when the construction of a number of piers was begun. At the beginning of the present century the total docks and basin work carried out since the earlier date covered an area of about 5 acres and included five docks and three basins.

The staple trade of the port of Swansea is coal and the continued growth of the tonnage entering the port during the latest years rendered it imperative that some considerable addition to the existing dock accommodation should be provided and after having obtained the necessary parliamentary powers the Swansea Harbor Trustees decided to construct a new dock, which should be sufficiently large to meet all the requirements of the port for many years to come and should have the necessary accommodation for receiving the largest vessels that are likely to be built.

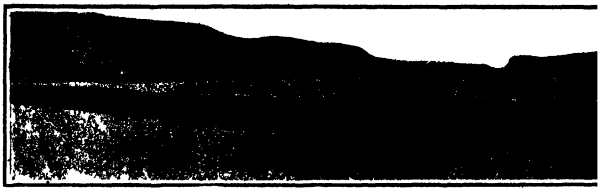
The principal trade of the new dock which was commenced in July, 1904 will be in coal and the arrangements of the berths sidings and approaches to the quays have been specially designed with this class of traffic in view. The total cost of the gigantic work including coal handling apparatus warehouses and machinery amounts to about $10 000 000.

The new dock now called the King's Dock possesses a water area of 8 acres in addition to the area of the deep water extension which when it is completed will add 40 acres to the total. The dock is irregular in shape and the entrance lock is placed so as to facilitate swinging. The largest vessel the lock can take will be able to swing in the dock near the lock without interfering with any ship berthed alongside the quays. The width of the dock at this point is 1 240 feet. The extreme length is 4 600 feet the width in the upper portion or coaling arm which is 4 000 feet long averaging 560 feet. The length of the quays reserved for general trade is 10 350 feet and for coaling purposes 2 800 feet making a total of 13 150 feet. In addition there are pitched slopes forming the dock sides for a length of about 100 feet which can be converted into wharves. The level of the impounded water is 35 feet above the dock bottom and 4 feet below coping level. The level of the water will be maintained by means of pumping when the increase in the number of lockings between spring tides has the effect of materially lowering the water level in the dock. Provision will be made for increasing the depth of water in the dock by 2 feet.

The most striking feature of the planning of the dock is the exceptionally large proportion of quay frontage to water area. This has been obtained without unduly restricting the water area required to enable vessels to maneuver or to lie at moorings on the dock awaiting a berth. The peculiar arrangement of projecting jetties in the coaling arm is designed with the view to economy of berthing space. The bays between the jetties which vary in length from 280 feet to 4[illegible] feet on the south side will be occupied by vessels of moderate length. These will be loaded by means of the movable coal hoists which will traverse as required to take up positions opposite the ship's hatchways. Other vessels the length of which may exceed the limits permissible in the bay berths will lie alongside the jetties overlapping the ships moored in the bays alongside the wharves. The ships at the jetties will be loaded by means of the fixed hoists and warped in or out as necessary to bring the hatchways under the tips. This device practically doubles the wharf accommodation and is we believe a novel arrangement in dock construction. The obvious criticism is the possibility of difficulties in mooring a large vessel broadside on to the end of a narrow jetty when a strong gale is blowing. The engineers have however provided heavy moorings at intervals along the middle of the dock. The mooring anchors consist of large concrete blocks sunk below the surface of the dock bottom. The mooring chains are shackled to mooring bars imbedded in the concrete.

For constructing the dock the first work undertaken was the reclamation of 400 acres of foreshore by means of a sea embankment. Within the area so inclosed the dock itself was constructed later. The sea embankment is nearly two miles in length and consists of a stone rubble bank protected on the sea face by large stone pitching no stone in the pitched face being less than two tons in weight the general average being about four tons. The stones were carefully set by two 8 ton capacity titan cranes. The foreshore at the site of the embankment is for the most part soft sand and beach at a level of 3 feet to 4 feet above low water of spring tides. The depth of water in front of the embankment at high water of spring tides is therefore about 20 feet. The toe of the seaward slope of the bank is formed by large stones not less than three tons in weight laid in a trench in the sand 6 feet deep. The stone embankment is surmounted by a concrete parapet and an apron the surface of the latter being at a level of 10 feet above high water of spring tide. The parapet wall is 7 feet high and shelters the reclaimed area from sea wash and spray. The method of construction of the sea embankment was as follows. A timber gantry, which averaged over 30 feet in height from the foreshore to the rail level was constructed on the foreshore along the center line of the embankment. Traveling pile driving stages each carrying three piling engines were started from two points and worked in both directions. Erecting gangs kept the construction of the gantries well in advance of the rubble mound. Train loads of stone rubble were brought on to the gantries and tipped until the latter structures became buried in the stone *débris*. The piles and other timber with the exception of the upper portions of the gantry were left buried in the rubble mound as the work proceeded. A little portion of the embankment was constructed without a gantry the materials being tipped end on as the bank advanced. A total of about 528-000 cubic yards of stone has been used in the construction of the embankment in addition to 1 213 000 cubic yards of sand from the dunes.

The dock walls as well as those of the lock are constructed throughout of 6 to 1 cement concrete faced with 4 to 1 concrete up to a level of 16½ feet below the coping. At this level granite oversailing courses project 6 inches beyond the lower part of the wall and from the top of the oversailing course up to the granite coping the wall is vertical and faced with blue brick. The face of the wall below the oversailing course batters 1 in 24 to 32 feet below the coping. Below that level the batter is increased to 1 in 2.75 down to the dock bottom. The foundations vary in



PANORAMA SHOWING AREA RECLAIMED BY

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THE NEW KI

depth, in places they were carried as low as 28½ feet below dock bottom, making the maximum height of the wall 69½ feet. The base width of the wall is 22 feet, which is reduced by steps to 7 feet under the coping. For the purpose of draining the ground at the back of the walls during construction, two 4-inch cast iron pipes are built into the wall at every 75 feet.

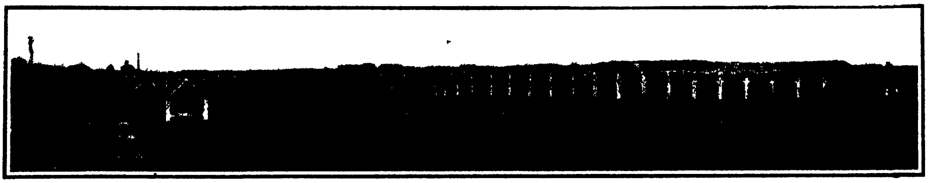
These drain pipes were sealed on the completion of the work. Vertical dry rubble stone drains are laid behind the walls at the back of the drain pipes, and a continuous dry drain is placed at the level of the lowest cast iron drain pipe. In those parts of the dock where no quays have been provided, the sides have been sloped to 1½ to 1 and stone pitched. The stone pitched slope is capped by a granite coping set on a concrete foundation. The material to be excavated from the dock consisted principally of sand and ballast, but in places considerable deposits of clay and numerous large boulders were encountered. Nearly the whole of the excavation was done by steam excavators, several types of these machines being used. The material excavated amounted to 4,000,000 cubic yards.

On the north side of the coaling arm the quay for a length of 750 feet is built of ferro-concrete on the Hennebique system. The same construction has been adopted for the coaling wharves on the south side of the arm, 1,148 feet in length, together with five jetties, which increase the total frontage of the ferro-concrete work on that side to 1,413 feet. This method of construction was adopted to obtain a greater width of firm foundation required for both the movable and fixed coal hoists than is possible with solid concrete walls. The ferro-concrete wharves are more costly than the solid wall when compared by the cost per foot of frontage, but there is a saving by the adoption of the former method when the cost of the heavy foundations for the hoists and crane roads at the back of the wall is added to the cost of the latter.

As said, the jetties fronting the south wharf are five in number, and all are 55 feet wide. The projection of the jetties into the dock varies, the middle one, which may be taken as typical, having a projection of 60 feet on the west face, while on the east face the projection is 115 feet, the difference being due to the *echelon* arrangement of the wharf faces and jetties. The construction of the ferro-concrete wharf on the north side follows the design of the wharf on the opposite side of the dock. The superload on the wharves is calculated at 2 hundredweights per square foot of deck in the way of the movable hoists, in addition to the actual load imposed by the hoists themselves, which is 304 tons for each hoist. The front beam of the wharf, which is 2 feet 4 inches by 1 foot 2 inches in section, carries a moving load of 200 tons on four wheels, the total wheel base being 36 feet. The remainder of the moving load of the hoist, viz. 104 tons, is carried by the back beam, measuring 3 feet 2 inches by 1 foot 8 inches. The deck elsewhere than between the movable hoist tracks is calculated for a superload of 3 hundredweights per square foot. The jetties which carry the fixed hoists and the viaducts leading to them are calculated on the same basis as the wharf work, the total load of each hoist being taken as 340 tons. The columns of the hoists are carried on 3½ feet square ferro-concrete pillars.

As already stated, a large portion of the eastern part of the King's Dock is to be devoted to coal traffic, and sections of the coaling wharves have been leased to railway companies, by whom they will be worked. When the coaling scheme is complete there will be a total of seventeen fixed and movable hoists provided in this part of the dock.

The entrance lock is placed at the southwestern corner of the King's Dock, and is 876 feet long between the pointing sills of the inner and outer gates, and 90 feet wide at coping level. The dock is subdivided by intermediate gates into two compartments, respectively 500 and 375 feet long. The main sluices, which are placed in shafts over the main filling and emptying culverts 6 by 10 feet, are raised and lowered by direct-acting hydraulic presses. In addition to the six main sluices the lock is provided with four floor sluices 4 by 6 feet, for use in clearing the gate chamber floors of any accumulation of mud. The lock is furnished with eight hydraulic capstans, four of which are capable of exerting a pull of 7 tons, and the other four of 5 tons direct from the barrel. The three pairs of gates are generally of steel and wrought iron of the water-borne type, and are alike in design, each gate being divided by means of two watertight decks and a central vertical watertight bulkhead into five compartments, the lowest of which extends the full length of the gate and is in free communication with the outer water through openings in the bottom deck. The two compartments above this form the air chamber, and the remaining two are water chambers free to the outer water through open upper pipes at the top deck of the air chamber, the position of this deck being arranged so as to insure a proper excess of weight over buoyancy at all states of tide.

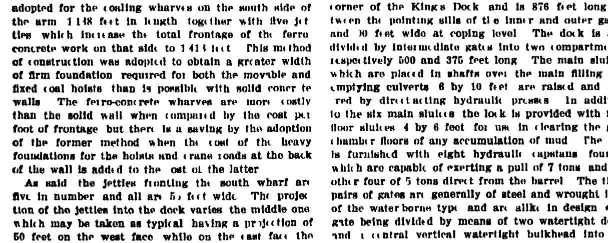


FERRO CONCRETE COALING WHARF. VIEW SHOWING FERRO CONCRETE COALING QUAYS.

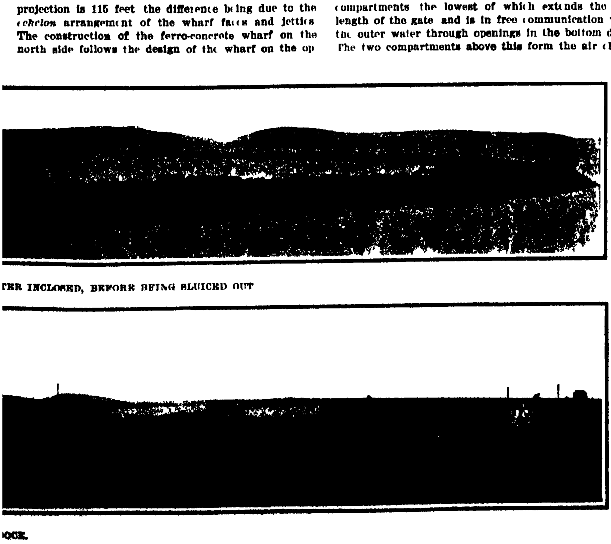
THE PARIS FLOODS AND THEIR PREVENTION

Although Parisians have breathed more freely since the subsidence of the floods, they have nevertheless not been without considerable anxiety. During the month the Seine has frequently risen to a level that in ordinary times would be looked upon as dangerous, and protective works have been hastily carried out in the shape of concrete walls to prevent the water from spreading in the event of its overflowing the banks. The presence of the danger has necessarily given special prominence to the measures which it is proposed to carry out for preventing the recurrence of any such disasters in the future. The problem is so complex that the commission which has been appointed by government to go thoroughly into the question includes engineers, architects, scientists, members of the various departments of public works, deputies and senators, and in fact everyone possessing special experience enabling him to throw some light on the matter. If anything, the commission appears a little unwieldy for dealing with a problem that requires urgent solution. Under the presidency of M. Alfred Picard it has drawn up a programme which covers no fewer than nineteen subjects, which are each to be reported upon by a specialist. Among the subjects are the following: Methods of predicting floods by improving the service of observation in the Basin of the Seine; embankments and parapets in Paris; influence of the Paris sewers on the floods; the effect of the bridges on the inundations; measures to be taken for the protection of the railways, the Metropolitan and the tramways, and for preventing any interruption to the telegraph and telephone service, as well as to the distribution of electricity, gas and compressed air; the relation between floods and the destruction of forests, and the carrying out of works for preventing any abnormal rise of the Seine level, especially so far as concerns Paris and the suburbs.

While, as will be seen from this outline, the programme of the Commission on the Seine Floods deals mainly with protective works, it is obvious that the most interesting feature of the problem lies mainly in the measures of prevention. If it is possible to prevent the floods, even at considerable expense, it may prove more economical to do so than to erect protective works. It is difficult, for instance, to see what can be done to prevent the sewers from playing such a disastrous part in the floods unless they are entirely reconstructed. Wherever they burst they tore up the roads, and even when the floods had subsided the falling in of a road was for the time being an almost daily occurrence. Besides, protective measures would apply to Paris alone, while anything which can moderate or prevent the overflowing of the Seine would be of incalculable benefits to a vast population in its valley, and might eventually be the means of putting an end to the perennial and destructive floods of the Rhone and the Loire. So far as Paris is concerned, a proposal has been made to widen and deepen the moat of the abandoned fortifications on the north side of the city, so as to constitute a canal which will relieve the Seine on its passage through Paris, where in times of floods it is partially dammed by the bridges and embankments. A similar project, it appears, was put forward fifty years ago, and was again suggested in 1872 by Belgrand, who pointed out that floods were bound to take place periodically. Another scheme aims at preventing floods altogether by sinking a number of absorption wells at suitable places in the basin of the Seine. These wells would be sunk in porous strata which would absorb all the water flowing into them, and thus as soon as the tributaries began to overflow their banks the surplus water would sink in the subsoil. As this system is successfully employed for reclaiming marsh land, it is one which will probably meet with due consideration from the commission. In view, however, of the tremendous volume of water which has been passing through Paris it would appear as if this system of



ER INCLOSED, BEFORE BEING SLUICED OUT



DOCK.

AT SWANSEA.

regulating the level would necessitate a very extensive and costly system of wells. Much has also been said concerning the destruction of forests, and doubtless a good deal is to be attributed to this factor, but there is a prevailing idea that while the reconstruction of forests is eminently desirable, it will not alone solve the problem of regulating the water level There is a considerable difference of opinion as to the value of the various schemes put forward, but absolute unanimity as to the necessity of doing something without delay to save Paris from another disaster.—The Engineer

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HEAVY ELECTRIC LOCOMOTIVES.[*]

SOME MODERN DEVELOPMENTS

BY C. L. DE MURALT

Except for the New Haven, which is a single-phase, and the Great Northern, which is a three phase plant, almost everything in the trunk line electrification in this country has been of the continuous, or direct current type. In Europe it is nearly otherwise, almost everything except one or two small installations having been of the three-phase, alternating current type The difference is mainly a commercial one The American engineers have shown just as much ingenuity and resourcefulness as European engineers, but the American manufacturer is given to exploiting one particular standard piece of apparatus just as soon as that piece of apparatus can be consistently sold, and can be made to do its work That means that American engineers in general are particularly encouraged in applying standard apparatus to the conditions which they meet, rather than in designing a new piece of apparatus for each particular case. In Europe, standardization was, until a very few years ago, practically unknown Even small motors were hardly what we call standardized, and each year every factory would turn out a new line of motors, and not only a new line, but they might change the 5 horse power and the 25 horse power motor, and perhaps afterward the 15 and 20 horse power Each installation was treated as a new problem, and for that new problem a new piece or pieces of apparatus were designed This explains why, in Europe, progress in electrification matters was much quicker than in America Each installation each road, was a distinct improvement on the one before, and there are no two exactly alike, while in America, on the contrary, we find one or two new ones, and then ten or twelve or more modeled after those in the standard fashion

The continuous-current equipment has long been with us here, as well as in Europe, in street railway practice, and therefore a natural thing was to use continuous-current apparatus for the first trunk line electrifications When it came to long-distance work, everybody recalls the limitations of low pressures which are an essential feature of continuous current equipment Therefore two methods were developed for overcoming these limitations One was to continue using continuous-current apparatus in the motor cars and locomotives but to transmit the energy at high pressure alternating current, and then to transform in the sub stations into continuous current The other method was to use alternating currents directly in the motors, the transmission being essentially the same

American engineers prefer the first method, European engineers choose the latter The reason for these two different choices is, again, a commercial one The American engineer had before him a well-developed series of standard continuous current motors, and he was loth to give that up for something which to him appeared as something entirely new He had plenty to do to develop the sub-station part of the alternating current and continuous current equipment, and therefore he chose the alternative. The European did not have a standard line of continuous-current apparatus, and therefore, as he had to design a new equipment anyway it was just as easy and just as logical for him to pick out the alternating current, which offered several advantages, the principal one at the time appearing to be the elimination of the rotary converter sub station, which we will all admit is not a particularly agreeable adjunct to a trunk line system This explains why, in Europe, all trunk line electrifications to date are of the three phase alternating-current kind while in America, all but a very few are of the continuous-current kind

At this date however both countries are getting to imitate each other The Americans are adopting the good points of European practice and the Europeans have already adopted a good many points of American practice I should like to point out one or two special points which I call modern developments in trunk line electrification and heavy electric locomotives from the American standpoint In Europe they have both been used for some time

The first one is the coming use of the side rods in electric locomotives The steam locomotive, of course, used side rods, because it was just about impossible to put a separate steam engine onto each driving axle When electric locomotives were first brought out, it seemed a very natural thing to do to get away from the side rods, because the electric motor lent itself so admirably to subdivision, and it was the easiest thing in the world to put an electric motor on each driven axle Everybody was very happy to do away with the side rods, because they were considered part of the reciprocating equipment of the steam locomotive which causes pounding and other disagreeable features, deteriorating the track, and causing a certain swaying of the locomotive By and by, it was found, however, that the side rods were not so bad as would appear at the first glance It is necessary to distinguish between different portions of the driving gear as used in the steam locomotive You have certain parts which are plainly reciprocating, like the piston, the piston rod, the crosshead, and a few others They cannot be counterbalanced They will have a direct motion to and fro, and to eliminate those parts in the electric locomotive was a great step forward The side rod pure and simple, however, which connects the first driver with the second and third, etc, is not, strictly speaking, a reciprocating part If you follow the motion of the side rod in one revolution, you see that it has rotary motion, and if you put a counterweight onto the other end of your crank shaft, and thus compensate for the weight of the side rod, you will find that the side rod will not have any hammer blow effect, in other words, it can be accurately counterbalanced Therefore, if the side rod has any advantages it is not necessary to eliminate that, and the side rod has very valuable features The first one is that it allows the raising of the center of gravity of the locomotive You may think that that is not an advantage, because when electric locomotives were first brought out, it was claimed for them as a particular advantage that their center of gravity was lower than the center of gravity of the steam engine, but, as is so often the case, this was found to be an error of judgment, and a very low center of gravity is not an advantage, but a disadvantage If you go to the other extreme, and raise the center of gravity very high, as is the case in the most modern steam locomotives, you hurt the design, and the locomotive gets to be top-heavy But between that and the very low center of gravity of the earlier electric locomotives, there is a vast difference A very low center of gravity was so hard on the track that it was really a mistake to place the center of gravity quite as low as it used to be placed in the beginning Therefore, as soon as this fact was realized—and, unfortunately, it was realized only after two or three accidents caused by the heavy effect of the low center of gravity on the rails—the designers immediately started to find means for raising the center of gravity So long as the motors were each one directly connected with its axle, it was difficult to do much in this line You will have seen pictures or drawings of some locomotives where the motors are raised and are put in a slanting position, not only for raising the center of gravity, but, incidentally, for bringing the center of gravity higher than it would be if they were placed horizontally But there were very small limits to this way of attacking the problem Practically the only, and by far the best method is to place the motor directly on the frame of the locomotive It might be still connected by gears as the early motors were, but that would be rather a difficult proposition It is very easy, however, to connect the motor by means of side rods, to place the motor on the locomotive frame, and then connect it by means of side rods with the driving axle, and this is one advantage which the side rods present, the possibility of placing the motor at whatever point in height is considered best

The second advantage, and probably just as valuable, is the fact that by means of side rods the entire weight of the motor can be spring-supported. Before side rods were used, the motors were connected by means of gears, or directly to the axle If they were directly connected to the axle, it was only by very complicated spring supports (placed in the wheels, like the New Haven locomotive) that the weight could anywhere nearly be supported by springs. If they were gear-connected, one-half the weight of the motor could easily be spring-supported. The other half, however, bore down directly onto the axle Whatever portion of the weight was not spring-supported had, of course, also a very hard effect on the track Therefore, the use of side rods, and with it the raising of the motor on top of the locomotive frame, where it could be entirely spring supported, together with the frame, was a step in the right direction.

A second modern development is the abolition of the commutator You all know that a continuous-current motor must have a commutator A commutator is not a serious proposition so long as the motor is used in laboratory, or, for that matter, in shop work, where it receives careful attention and periodic inspection, and where it is not subjected to overloads of any serious nature The railway motor, however, works under entirely different conditions It runs through all kinds of weather It gets wet, and hot, and dusty It is not inspected any too often, even on the most careful roads It is frequently quite habitually subjected to overloads, and therefore it is really handicapped from the start, and its commutator is the point which shows the bad effect first The windings of the field and of the armature can be protected against all these bad treatments, but the commutator is an exposed point Commutators will spark at best, but if they are poorly treated, they will spark badly That means that the brushes will be eaten up, and then the commutator itself will be eaten up, and this takes place to such an extent that almost any railroad, be it street railway or trunk line, which uses continuous-current motors has a great amount of its reserve for motor repairs expended on the commutator The percentage varies I do not believe it is ever less than 10 per cent., it is mostly above 50 per cent and it goes as high as 80 per cent of the total repairs for repairs on the commutators alone Therefore to get away from the commutator is, indeed, interesting You cannot abolish the commutator unless you use an alternating current motor You cannot do it even with a single-phase alternating current motor because the single phase induction motor is not, in its present stage of development, suitable for railway work It will not present the proper starting characteristics The single phase series motor has, of course, a commutator, because it is practically only an improved continuous-current motor The only motor which can do without the commutator is the three-phase alternating-current motor, and therefore the use of the three-phase alternating current, in addition to all the other advantages, presents the one great and financially interesting advantage of eliminating the commutator

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In a paper on "The Mechanics of Dust," read before the Society of Engineers by Mr. C H W. Biggs, the author says one of the most interesting investigations, and one open to every student, is that of the effect of minute air currents upon dust particles Imagine for a moment dust particles having a very large surface compared with their mass. Fortunately, the student can on occasion easily see such particles, and watch their evolutions, in a room where otherwise it is almost, if not quite, impossible to detect air currents by other means. Smoke consists of small particles of matter, and is in daily use to detect minute currents of air both in drains and in rooms. There is an excellent way to investigate and to follow the motion even of individual particles. Dr. Travis, in his experimental work on seeing colloidal matter, makes great use of the ultra-microscope. You can get something of this effect in rooms where a window faces a bright sun. Darken the room, leaving only a hole—preferably circular—through which to get a beam of bright sunshine Thus we get a cone of brilliant light through the room. In this cone you can see dust particles playing all manner of antics, some falling, some rising, some going in one direction, some in another, the direction of the small masses being the direction of the resultant of the forces acting.

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[*] A lecture given before the Worcester Polytechnic Institute Branch of the American Institute of Electrical Engineers, Worcester, Mass.

PARADOXES OF ACCELERATION.

A SUGGESTION FOR THE TEACHER OF MECHANICS.

BY C. E. GUILLAUME.

Among the very subtle notions which often embarrass the teacher of mechanics, none more frequently leads to erroneous interpretations than the two aspects in which acceleration may be considered, but there is also none which, when once mastered, is more fertile of results in thorough instruction. The nature of the question will appear clearly on consideration of the following problem. If a railway tank car is stopped on an incline, the surface of the liquid will evidently be horizontal, but if the brake is released and the car allowed to move freely, the friction being supposed negligible, what form will the surface of the liquid then assume? If this question should be asked of a number of persons expert in mechanical problems, few would be found able to answer without prolonged consideration. Hence this problem, simple though it appears, is a difficult one. We shall associate with it a number of similar problems, which will enable us to understand it better.

It is not possible for everyone to experiment with the tank car, but every reader can walk through an ordinary railway car at the moment of starting or stopping. He will then observe a singular fact. At the moment of starting the floor of the car will seem to be raised in front and at stopping it will appear to be raised behind. In the Paris subway where the accelerations are considerable this phenomenon is very striking. A passenger walking forward at the moment of starting experiences the sensation of ascending a steep grade. This illusion the explanation of which we shall see later foreshadows the solution of our problem, but we must make still another digression in order to attack the problem without difficulty.

Every body which is free to move is caused to fall vertically by the attraction of the earth. If the body is prevented from falling, it exerts upon its support a pressure which we call its weight. Now what is the weight of a body which is falling freely? This is a difficult question, to which an erroneous reply is often given. A very simple process of reasoning will show us the truth. Let us suppose that two coins are laid, one upon the other on a board, and that the board is suddenly snatched away. As long as the lower coin was supported by the board, the upper coin pressed with all its weight upon it. Does the same condition prevail during the fall of the coins? Certainly not. In fact, each coin falls, with an acceleration equal to g under the action of its own weight. If we suppose that in these conditions the upper coin continues to press upon the lower one it is evident that the latter will be subjected to a total force which is greater than its own weight while the upper coin will experience a downward force less than its weight. Hence the acceleration of the lower coin will be greater, and that of the upper coin will be less than g, and consequently the coins will immediately separate. As this reasoning remains true, no matter how small the mutual pressure of the coins is supposed to be, we see that while falling freely, the coins cannot exert any such mutual pressure.

These facts are evident enough, yet heresies abound in this field, and some very celebrated ones have been accepted almost without comment. The novelist Jules Verne, in order to remove his travelers to the moon from the action of gravity, carries them to that point in space in which the attractions due to the earth and the moon counterbalance each other. This expedient was unnecessary. The projectile in which the travelers were inclosed, would have fallen freely toward the earth as soon as it was free to move. Although its speed of ascent was very great, its downward acceleration would have preserved its normal value. As the passengers fall with the vehicle there would be no mutual attraction between them and it, and they would be able to move with a freedom unhampered by gravity, without having to wait until they reached a certain point of space.

The complete verification of this statement is unfortunately impossible, but partial proofs can be found without difficulty. The commencement of the descent in a mine elevator is accompanied by a marked feeling of discomfort, which is due to the fact that the acceleration, although very much less than that of gravity, is large enough to destroy a considerable proportion of the pressures which the various organs of the body normally exert upon each other. The stomach, suspended in midair as it were, unmistakably indicates that it does not relish these conditions of existence, and if the action continues, or is repeated frequently, as it is on a rough sea this organ makes an energetic protest.

Now let us see what will happen to a pendulum if its support yields to the attraction of gravitation. A process of reasoning analogous to the above shows that, if the descending movement begins at the moment when the pendulum has attained its greatest elongation it will remain in this inclined position as long as it continues to fall freely. If the fall begins during the oscillation of the pendulum, the latter will rotate in a vertical circle with a constant angular velocity. These results might be expressed by saying that as the weight of the pendulum is employed in causing it to fall it cannot also cause an oscillation, this will be asking too much of it. It will be more exact to say, however, that, as the pendulum experiences no reaction from its support, it is not subjected to any mechanical couple, and consequently has no tendency to modify its rotation.

This reasoning explains why clocks are little affected by the attraction of the sun and moon. If the moon revolved about a motionless earth, clocks would run slow when the moon is in the zenith and would run fast when it is in the nadir. But in fact the earth and moon are constantly falling toward each other, as if all the matter of each were collected at its center consequently the moon would exert no action whatever upon a clock placed at the center of the earth. On a clock at the surface of the earth only a differential action is exerted, which is too small to be perceptible.

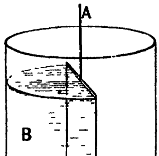

Fig. 1.

THE VERTICAL WALL OF WATER

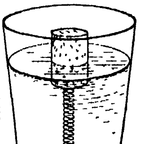

Fig. 2.

THE PLUNGING CORK

When these principles are applied to liquids, they produce some very astonishing results. Let us first consider a simple problem. A cylindrical vessel (Fig. 1) is divided into two parts by a vertical partition passing through its axis. The part on one side of the partition is filled with water, while the other part is empty. The vessel is allowed to fall and at the same instant the partition is removed, leaving to the water absolute freedom of movement. What form will the water assume? The answer is simple. The water will maintain its form unchanged, i. e. it will continue to fill one half of the vessel, preserving a vertical face, as if the partition had not been removed. The reason is that the water and the vessel are both falling freely, and are thus removed from the action of gravitation.

A still more surprising result can easily be obtained by an experiment devised by Prof. G. de Metz, who repeats it annually in his course of lectures at the University of Kieff, and who recently communicated it to me. In a glass of water (Fig. 2) floats a cork, attached to the bottom of the glass by a spiral spring, the tension of which is only sufficient to increase slightly the immersion of the cork. If the glass is dropped, what will the cork do? The answer is very surprising. The cork will plunge deeply into the water. The truth of this assertion is apparent upon a little reflection. We learn from the preceding experiment that water exerts no pressure upon the vessel which contains it when both are falling freely. For the same reasons, the various strata of the liquid exert no mutual pressure, or in other words, there is no pressure in the interior of the liquid. Now as the rise of the cork to the surface is due to this internal pressure, in the absence of the latter the cork will necessarily plunge downward under the impulsion of the spring, which is the only force acting upon it. At the moment when the glass touches the floor, gravitation reasserts itself. A considerable pressure is developed in the interior of the mass of water and the cork emerges suddenly.

For the reasons which have been indicated above, the bubbles which rise in sparkling wine cease to rise if the glass is dropped to the floor, and rise more rapidly if it is knocked against the table.

Now let us return to the problem of the railway car. Experimenting upon one's self is not always a rapid process of discovery. Let us rather drop a small coin from the ceiling of the car at the exact moment of starting. It is certain that the coin will actually fall in a vertical line, but, as the car is in motion, the coin will appear to descend obliquely. Hence the horizontal plane which is perpendicular to this line of fall will appear to descend toward the front of the car or in other words, the floor of the car will appear to be raised in front. But the experiment with our own body teaches us a little more, namely, that the real acceleration of the train is combined with the virtual acceleration of gravity (the acceleration which gravity would communicate to us were it not for the reaction of the floor of the car) to form an oblique resultant, which gives us an erroneous idea of the position of the vertical line. In free fall as we have seen above, the idea of verticality ceases to exist. In Jules Verne's projectile it would have been quite impossible to decide by the muscular sense alone the direction in which the earth was situated. The preceding problems are connected together by this modification of the idea of up and down.

The problem of the tank car remains to be solved. In this case there is free acceleration in the direction of motion and in this direction the notion of force ceases to exist. The only component which can make itself felt by a mutual action between the liquid and the car is that component of which the real acceleration is annuled by the reaction of the rails. Hence the surface of the liquid will place itself at right angles to this direction, i. e., parallel to the rails, just as if the car were at rest on a level track.

An application of this principle immediately suggests itself. Attempts have been made to construct grade indicators for automobiles and aeroplanes, but the results hitherto obtained with such devices have been very unsatisfactory. This is because the virtual acceleration of gravity, which acts along the true vertical, is combined with the real acceleration in the direction of motion and as the latter often predominates it makes the indications of the instrument absolutely nugatory. If the instrument, furthermore, contains parts which are free to move in the direction of the motion of the car, all rotating parts are affected by centrifugal acceleration, as well as by the variations in the slope of the path.

This is also the reason why altitudes measured with a sextant held in the hand on the deck of a vessel require to be reduced, either to the true horizon or to an artificial horizon, such as is given by the Fleuriais top. The level of the sextant furnishes an instantaneous horizon, i. e., the plane perpendicular to the resultant of the real and virtual accelerations.

Hence we see that the same principle reappears in many fields, and, when it is not perfectly understood, apparently simple problems produce great perplexity. Several of these problems are of great practical importance and deserve serious study.—La Nature.

Indelible Pictures (France Pat.). One or both sides of the picture (on paper, linen, silk, wood, etc.) should be covered with a thin, translucent sheet of pyralin celluloid, or other composite substance, having pyroxyline for its chief constituent. The picture can be covered only on one side, the front, or on both sides with a sheet of pyralin. In the latter case, as only the pyralin sheet on the front side needs be transparent, the back sheet can be of any desired color. The sheet or sheets of pyralin are first prepared in the familiar manner and attached to the picture by moistening its surface with alcohol, or some other solvent of pyroxyline, and then applying warmth and pressure. We can also use a transparent cement or mucilage to fasten the leaves, or no solvent at all employing only heat and pressure. A back of card or wood may be applied to the picture, in which case the pyralin sheet is applied only to the front of the picture. After the picture has been firmly fastened between the pyralin sheets they can be polished in the ordinary manner, i. e., by pressing them against a highly polished metal plate, or they can be polished first and then fastened to the picture.

A NEW METHOD OF REVERSING TURBINES.

FOETTINGER'S TURBINE PROPULSION SYSTEM WITH TURBO-TRANSFORMERS.

The application of turbines to ship propulsion commends itself by advantages such as uniform torque and strains, avoidance of vibrations, simplicity of operation, saving in lubricants comparatively small wear at bearings, and the possibility of "forcing" the engine, that is, driving it at abnormally high speeds Yet the turbine has not been able to supplant the reciprocating steam engine in ship propulsion There are two reasons for this fact:

First, no practical reversible turbine has been designed so far, and since it is necessary that a ship should be capable of backing astern, separate (normally idle) turbines had to be added for this purpose; as generally constructed, these reversing turbines have a maximum power amounting to from 30 to 45 per cent of that available for forward propulsion, whereas reciprocating engines allow from 70 to 90 per cent of the power available for forward propulsion to be utilized for backing, at all speeds A ship fitted with reciprocating engines can therefore be stopped and reversed more quickly than a turbine ship of the same power.

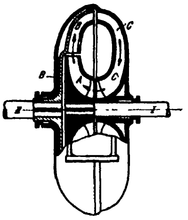

Fig. 1.—TYPE OF TURBO TRANSFORMER.

Second, screw propellers are most efficient at a rate of speed considerably lower than the rate of speed which is best for efficiency and economy of turbine operation (from five to fifteen times lower)

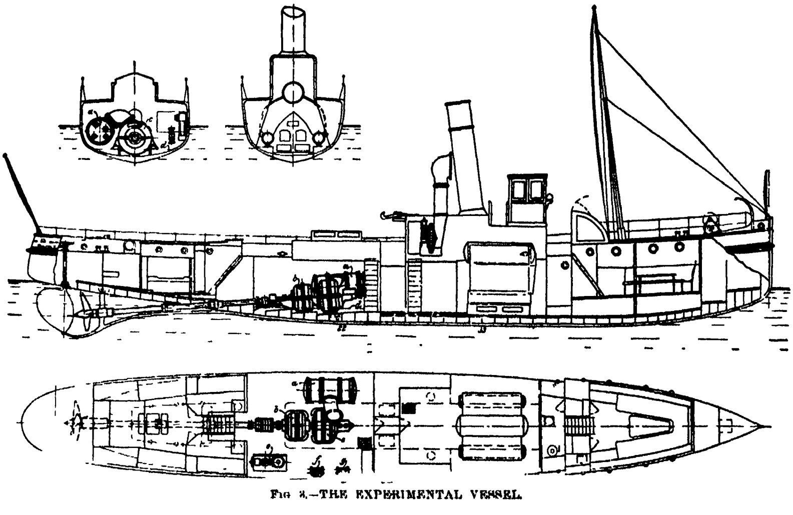

Fig. 3.—THE EXPERIMENTAL VESSEL.

In most constructions devised hitherto a compromise has been adopted that is to say, the propeller and the turbine shaft have been given the same speed, intermediate between those at which each of these elements would yield the best results As a consequence, the efficiency of the propeller has been reduced, while the weight of the turbine has been increased

If it be desired to operate propeller and turbine at their proper economical speeds the interposition of speed reducing mechanism between them becomes imperative Toothed gearing as proposed hitherto is asserted to be unsuitable for high speeds or for transmitting high powers, moreover, it does not reverse. Electrical gearing would be too heavy and too bulky for practical purposes Hydraulic transmission of a crude form has been proposed, the turbine driving a centrifugal pump which propels a body of liquid against the buckets of a wheel (say a Pelton wheel) whose shaft carries the propeller This transmission has a low efficiency, chiefly on account of losses in the propulsion of the circulating liquid.

To overcome these drawbacks, Dr. H. Fottinger of Stettin, Germany, assisted by the Vulcan Works, has invented and developed a system of propulsion for which he claims not only a high degree of efficiency, but reversible action without mechanical complications. The feature of this invention is a very compact and relatively light and simple hydraulic transmission device, the so-called turbo-transformer.

The accompanying diagrams illustrate two types of the new turbo-transformer. In each view, *I* indicates the drive shaft, that is the turbine shaft, to which is secured rigidly the rotary pump *A* Independently rotatable is the driven shaft or propeller shaft *II*, carrying rigidly the water wheel *B*. The parts shown in solid black are stationary and contain guide channels *C* which together with the buckets of the pump *A* and of the wheel *B* form a closed circuit for the water or other liquid employed as the transmitting medium. In the first diagram, the pump throws the liquid direct into the water wheel, from which the liquid returns to the pump through the guides *C*; in the second diagram, the liquid passes from the pump first through the stationary guide channels and then to the water wheel, from which it has a direct return to the pump

The energy imparted to the liquid by the pump *A* is absorbed largely by the water wheel *B*, and inasmuch as the liquid returns to the pump immediately, there is very little loss of energy, the energy remaining in the returned liquid reduces the energy required to operate the pump or in other words, the load on the turbine shaft By properly selecting the dimensions of the parts, the desired ratio of speed is obtained between drive shaft and driven shaft.

Dr Fottinger has devised buckets and blades specially adapted for the new use In practice, the types shown in the diagrams have been modified and combined in various ways; more particularly an intermediate wheel, rotating independently, has been interposed between the pump and the driven wheel carried by the propeller shaft. Turbo-transformers with one or more intermediate stages are advisable when a considerable reduction of speed is desired.

Dr Fottinger has noted the possibility of using his invention to increase speed instead of reducing it.

This new system of propulsion offers very marked advantages First of all, the apparatus is very compact, which involves a saving in space, weight, and cost, and in view of the fact that the power-transmitting liquid circulates in a short path, losses due to friction and whirling are reduced to a minimum. The inventor further avoids the considerable losses which in the crude form of hydraulic transmission above referred to are due to the double conversion of energy, first from velocity to pressure, and then back from pressure to velocity. Again, the velocity which the water still has when it leaves the driven wheel of the turbo-transformer is not wasted, but assists in propelling the liquid through the pump The production of a vacuum and corrosion due to it are excluded by the continuous motion of the liquid in a direct path; moreover, if desired, a standpipe, tank, pump or other means may be connected with the circulating space to produce any desired pressure therein.

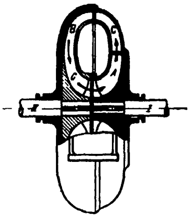

Fig. 2.—TYPE OF TURBO TRANSFORMER

A point of chief interest, of course, is the efficiency of the new system Calculations made by Dr. Föttinger before practical trials, led him to expect an efficiency of from 80 to 82 per cent in the case of large units and a speed reduction ratio of from 1/4 to 1/5. These calculations were based on well known figures concerning the efficiency of rotary pumps and water wheels. The efficiency of standard rotary pumps runs from 80 to 84 per cent, and a low-pressure centrifugal pump devised by Dr. Föttinger has shown an efficiency up to 86 per cent. Water wheels of good construction have efficiencies of from 84 to 85 per cent,.even with small units. These figures take into account the loss of energy at the outlet. In the turbo-transformer this loss is avoided, as the liquid re-enters the pump immediately; therefore, even if the loss at the outlet is assumed as low as 3 per cent, the pump of the turbo-transformer would have an efficiency of from 86 to 87 per cent and the water wheel an efficiency of from 87 to 88 per cent Since this pump consists only of a set of rotating buckets or blades all the losses occurring in the other parts of an ordinary centrifugal pump are eliminated and the efficiency of the rotary pump member alone will be about from 93 to 94 per cent When connected in series with the water wheel this pump forms the turbo-transformer whose efficiency is equal to the product of the individual efficiencies, that is, from 0.93 × 0.87 = 0.81 to 0.94 × 0.88 = 0.83 or from 81 to 83 per cent In practice an even higher efficiency has been attained in some cases

The efficiency depends on the reduction ratio With a reduction ratio between 1/4 and 1/6 an efficiency of from 80 to 82 per cent is readily obtained employing two reduction stages (that is one intermediate stage) A speed reduction in the ratio of 1 to 8 is obtained with three stages and an efficiency of about 80 per cent Calculations made by the Vulcan Works in connection with the proposed installation of the turbo transformer in rolling mills indicate an efficiency of about 75 per cent with a speed reduction ratio of 1/11 or 1/12 Even higher reduction ratios may be employed in cases where absolutely uniform speed is not essential

When a steam turbine is used to drive the turbo transformer the total efficiency of the plant can be increased further by recovering the waste heat If the transformer has an efficiency of 80 per cent, this means that 20 per cent of the power applied to the pump is converted into heat raising the temperature of the circulating liquid With a direct drive from the pump and a water wheel is used for rotation in both directions while the other part (in this case the guide channels) can be altered to reverse the rotation of the wheel Some water wheels have buckets so formed that they can run in either direction With such, reversing can be obtained by movable or adjustable guide channels thrown to one position or the other by a hand lever or special mechanism Or two connected sets of guide channels may be employed one formed to produce forward rotation and the other to produce rearward rotation and by shifting one set of guide channels or the other into operative position rotation of the desired direction is obtained In this second type the circulating path remains full of water even upon reversal of the propeller

Third When very quick reversal is desired there may be used in combination with an arrangement of the first or of the second type a device for temporarily throwing one of the circulating paths out of action while leaving it filled with water

Another important question is the adjustment required to change the number of revolutions of the propeller shaft so as to alter the speed of the ship With a constant speed reduction ratio of the transformer the energy absorbed by the transformer varies as the cube of the number of revolutions The same law (with close approximation) obtains as regards the screw propeller and therefore when the turbo transformer is applied to ship propulsion the speed reducing ratio of the transformer will remain constant without the provision of any governor The number of revolutions of the propeller shaft will therefore be varied simply by adjusting the action of the steam uses such devices might be necessary or desirable and designed different types described in patents These regulating devices may be of the same character as the reversing devices explained above that is adjustable blades or buckets or guide channels arranged to be shifted into or out of operative position or throttle valves etc Regulation may also be effected by varying the number of stages in operation Thus by employing say only one stage for top speed and say two stages for cruising speed a higher speed reduction ratio will be obtained at cruising speed while the steam turbine is operated at a practically constant speed A transformer of this character is now building at the Vulcan Works

Dr Föttinger's turbo transformer was first subjected to a thorough practical test in 1907 The driving engine was not a steam turbine but an electric motor of 100 horse power (capable of developing up to 182 horse power) having 1 000 revolutions per minute The driven shaft was intended to perform 220 revolutions per minute that is the speed reduction ratio was to be about [illegible] to 1 The turbo transformer had two circulating paths a two stage path for forward rotation and a one stage path for reverse rotation Leakage from one path to the other (about 1 per cent) was collected in a tank and returned by means of a replenishing pump A piston valve controlled the circulation of the water through one path or the other

The tests made with this experimental arrangement under varying conditions of motor power and load bore out Dr Föttinger's calculations The torque was found to rise considerably when the driven shaft was

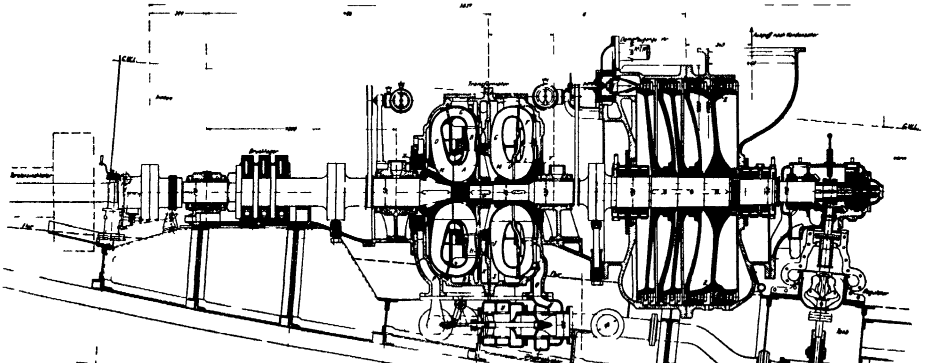

FIG 4—LONGITUDINAL SECTION THROUGH ENGINE ROOM OF EXPERIMENTAL VESSEL

5 to 15 per cent of the engine power is wasted as heat absorbed by the sea, with the turbo transformer the heat developed in the transformer can be recovered almost totally and utilized say for heating the feed water temperature of which can thus be increased 20 or even 25 deg C without any consumption of coal for this purpose The feed water may simply be made to circulate through the transformer and will remain of a practically constant temperature notwithstanding variations of the load since with a reduction of condensation water there is also a reduction of heat loss Heating the feed water in this manner increases the steaming capacity of the boilers and thus the power developed to the extent of from 3 to 4 per cent so that a transformer having an efficiency of 80 per cent may be made equivalent to one having an efficiency of 83 per cent

A very important advantage of the turbo-transformer is that it can be readily made reversible while the steam turbine always revolves in the same direction and is controlled by a governor Three types of reversing arrangements are described by Dr Föttinger

First The transformer has separate circulating paths for forward and rearward propulsion respectively The temporarily idle path is emptied into a tank. The shifting of the circulating water from one path to the other can be accomplished with the aid of the powerful centrifugal pumps of the transformer, or a separate small auxiliary pump may be supplied to return water to the circulating paths and also to replace any leakage A balanced slide valve governs the admission to one path or the other In the stopping position both paths are emptied

Second One part of the transformer, for instance turbine driving the pump The efficiency of the transformer is also practically constant within a relatively wide range of speed

It is well known that a steam turbine has its maximum efficiency at a determined number of revolutions When the turbine is coupled direct with the propeller shaft it is necessary on account of weight considerations to give the turbine (even at top speed) a number of revolutions which is from 10 to 30 per cent below the one of maximum efficiency When operating at reduced speed (cruising speed) a considerable loss of efficiency occurs With a turbo transformer the steam turbine at top speed may be given a number of revolutions even exceeding that of maximum efficiency so that a reduction of the ship's speed will actually for a time increase the efficiency of the steam turbine, and in any event the reduction of turbine efficiency, from top speed to cruising speed is much less with a turbo-transformer than with direct transmission In a particular case investigated by Dr Föttinger the reduction of turbine efficiency from top speed to cruising speed was found to be 30 per cent for the direct drive and only about 16 per cent for the turbo transformer system thus assuming both systems to be equally economical at top speed the transformer system would show an economy of

$$\frac{(1 - 0.16) - (1 - 0.3)}{1 - 0.3} = 20$$

per cent over the direct drive at cruising speed

While as stated above no device for regulating the speed of the transformer and particularly for varying its speed reduction ratio is required for the propulsion of ships, Dr Föttinger realized that for other stationary so that a quick starting of this shaft was obtained together with a rapid acceleration to normal speed The maximum efficiency within wide limits of motor speed was secured with a speed reduction ratio of 4.25 to 1 (against a calculated ratio of 4.45 to 1) When keeping the motor speed constant (say at 1 100 revolutions per minute) and varying the rotary speed of the driven shaft a maximum efficiency of about 83 per cent was found at 260 revolutions corresponding to the speed reduction ratio just stated When varying the power supplied by the motor (that is its number of revolutions) the efficiency rose with an increase of power With [illegible] horse power the efficiency was more than 70 per cent with 9½ horse power 75 per cent with 40 horse power 80 per cent with 100 horse power, 82½ per cent and with 182 horse power 83 per cent When reversed the turbo transformer showed a maximum efficiency of 70 per cent so that the power available for reverse rotation was about 70/82 = 85 per cent of the power furnished for forward rotation This proportion is from two to three times as large as that obtainable in practice with propellers driven directly by steam turbines The proportion might be increased further by employing two or more stages in the circulating path employed for reversing

In view of the satisfactory results obtained the Vulcan Works proceeded to install the same turbo transformer in a screw propeller ship built specially for this purpose This ship of 76.7 tons had a length of about 90 feet a beam of about 14 feet and a draft (including the keel of about 4 inches) of about 5 feet The driving engine was a Curtis steam turbine with four wheels each having three rows of blades Steam was supplied by a water tube boiler at a pressure of 17 atmospheres, the grate surface being 31 square feet and the heating surface 1,614 square feet The shaft of the turbine carried directly the two centrifugal pumps of the turbo-transformer Provision was made to balance the axial thrust The replenishing pump required only about ¼ of 1 per cent of the turbine energy The boiler and turbine were rated at 500 horse-power. The number of revolutions of the turbine was selected as 1,750, a speed reduction ratio of 4.5 to 1 would have required 390 revolutions per minute for the propeller shaft, but for special practical reasons the propeller was made larger than it would have been in most cases, and the number of revolutions decreased to about 318, which meant giving the speed reduction ratio the increased value of 5.6 to 1

This ship developed a speed of from 12 to 13 knots and was used as a cargo boat, as an ice breaker, as a ferry, as a tug for towing a cruiser, etc Its behavior was highly creditable, especially in heavy seas The reversing of the propeller was particularly remarkable. With the ship going ahead at full speed, the reversing lever was thrown from "ahead" to "astern," the engine continuing to rotate in the same direction, the propeller shaft came to a standstill after four or five seconds, and within ten more seconds had acquired a reversed speed of from 200 to 250 revolutions The stopping action was so powerful as to produce on the persons aboard a sensation similar to that experienced when the brakes are applied on a street car.

Dr. Föttinger has made elaborate calculations of the dimensions and efficiencies which would result from the adoption of his turbo-transformer in larger ships, up to 40 000 horse-power, and has also investigated the possibility of utilizing his invention for other purposes, as in rolling mills He suggests that the turbo-transformer may find a profitable application in connection with gas turbines as well as steam turbines, or with internal combustion engines of the piston type, particularly in view of the fact that such engines are not reversible.

AEROPLANE STABILITY.*

SOME NEW THEORIES.

BY G. H. BRYAN.

In 1896 I had the pleasure of attending a lecture on naval architecture given before the British Association in Liverpool by the late Dr Francis Elgar, F R S I had learned the theory of the metacenter in my undergraduate days, but it came to me as a great surprise to learn that this theory had only been evolved after many ships had foundered, owing to want of theoretical knowledge of their conditions of stability

I was interested in aerial navigation at the time, and although I had not got further than throwing gliders, it was evident from their behavior that a mathematical theory of stability must necessarily be of even greater importance in connection with aerial navigation than with naval architecture, and I wrote in Science Progress to the effect that if the future development of artificial flight were not to be a repetition of the chapter of accidents by which naval architects had gained their theoretical knowledge there would be abundant work for mathematicians in reducing the conditions of stability to pure calculation

About the year 1903 I noticed that if a glider or other body is moving in a resisting medium, such as air, in a vertical plane with respect to which it is symmetrical, the small oscillations about steady motion in that plane are determined by a biquadratic equation; and Prof Love directed my attention to the condition of stability given by Routh Mr W E Williams was a post graduate student in my department, and with his collaboration we published a paper on "The Longitudinal Stability of Aerial Gliders (Proc Royal Soc, lxxiii), which was intended to direct attention to the general method, and the importance of further investigation, rather than to furnish a complete solution of the problem

Mr Williams shortly afterward obtained a so-called "Research Fellowship', but "research' in this case was interpreted as meaning practical work done in a physical laboratory away from Bangor, so the award had the effect of preventing the continuation of original work on this important problem On the other hand, the necessity of providing, with one assistant, classes in all grades of pure and applied mathematics, and of devoting special attention to the requirements of junior students whose knowledge of the "first four books and of arithmetic had been neglected at school, left no time for me to carry on the work single handed It is only since the comparatively recent abolition of these *infra* university courses that I have been able to give any attention to the subject

Some criticisms having been raised by the late Captain Ferber, mainly referring to the form in which the conditions of stability were stated I suggested his developing the work as I had not time to do so His results were published in the Revue d Artillerie, October and November, 1906, and include a discussion of lateral as well as of longitudinal stability

At the beginning of last year the work of my department was, for some unknown reason, exceptionally light, and I had in Mr E H Harper an assistant well able and willing to collaborate in a much more exhaustive investigation both of longitudinal and lateral stability About October I received a formal letter of inquiry from the Government Committee, in an envelope which I at first took for an income-tax application, and in reply stated that what I wanted was a small grant to enable me to devote my whole time to this work I received a reply that the committee 'regretted,' etc, but that "very great interest was taken' in the work The main difficulties of the subject have, however, now been practically cleared up though a long time must elapse before a detailed written account is ready for publication Had any prizes been offered in England for which such an investigation would be eligible, the delay might have been avoided or shortened

Reference must be made also to Mr Lanchester's remarkable investigations, published in his "Aerodonetics" and to the appearance of a German translation of the preceding volume 'Aerodynamics,' shortly after its publication in English

It is here proposed to give a general idea of the peculiarities of aeroplane stability as deduced from my work, and a comparison with Ferber's and Lanchester's methods, though with regard to the latter it is rather difficult for any critic to be sure of not misjudging the author's intended meaning

It is necessary that the distinction between equilibrium and stability should be kept in mind An aeroplane is in *equilibrium* when traveling at a uniform rate in a straight line, or, again, when being steered round a horizontal arc of a circle A badly balanced aeroplane would not be able to travel in a straight line The mathematics of aeroplane equilibrium is probably very imperfectly understood by many persons interested in aviation, but it is comparatively simple, while the theory of stability is of necessity much more difficult

It is necessary for stability that if the aeroplane is not in equilibrium and moving uniformly it shall tend toward a condition of equilibrium At the same time, it may commence to oscillate, describing an undulating path, and if the oscillations increase in amplitude the motion will be unstable It is necessary for stability that an oscillatory motion shall have a positive modulus of decay or co-efficient of subsidence, and the calculation of this is an important feature of the investigation A slight reference to this question of rolling is given by Chatley on p 99 of "The Problem of Flight,' but he seems to have overlooked the fact that this damping may be, and often is, negative in the case of unstable aeroplanes

At the present time it is certain that aviators rely on their own exertions for controlling machines that are unstable, or at least deficient in stability and they even allege that, owing to the danger of sudden gusts of wind, automatic stability is of little importance Moreover, even in the early experiments of Pilcher, it was found that a glider with too V shaped wings, or with the center of gravity too low down, is apt to pitch dangerously in the same way that increasing the metacentric height of a ship while increasing its "statical" stability causes it to pitch dangerously It thus becomes important to consider what is the effect of a sudden change of wind velocity on an aerodrome. If the aerodrome was previously in equilibrium it will cease to be so, but will tend to assume a motion which will bring it into the new state of equilibrium consistent with the altered circumstances, provided that this new motion is stable Thus an aerodrome of which every steady motion is stable within given limitations will constantly tend to right itself if those limitations are not exceeded Excessive pitching or rolling results from a short period of oscillation combined with a modulus of decay which is either negative (giving instability) or of insufficient magnitude to produce the necessary damping

The new work depends very largely on the property that for a system of narrow aeroplanes inclined at small angles to the line of flight approximate methods may be used, greatly simplifying the algebra, and enabling the various oscillations to be separated and their moduli of decay to be calculated approximately Of the six equations of motion as applied to the small oscillations of a symmetrical aerodrome, three determine oscillations of symmetric or longitudinal stability The other three determine asymmetric or skew symmetric stability The three equations in each set are mutually interdependent, but independent of the other three, thus accounting for the fact that Lanchester found it impossible to separate "lateral' and directional stability Failing any better terminology, I have provisionally adopted the term "asymmetric' stability

Of the two, symmetric stability presents by far the simpler problem For the systems above mentioned there are two symmetric oscillations, one of long and one of short period The short period oscillation consists mainly of an oscillatory motion of the center of gravity perpendicular to the line of flight (i. e, a vertical oscillation if the aerodrome is moving horizontally), combined with a rotatory oscillation about the center of gravity. To a first approximation it produces no fluctuations in the velocity in the line of flight, and is unaffected by head resistance or fluctuations in the propeller thrust, provided the latter passes through the center of gravity of the aerodrome, as has been assumed in many of our calculations The condition of stability depends only on the areas and positions of the aeroplanes relative to the center of gravity, and is independent of the inclinations or angles of attack of the planes, the oscillations remaining finite when the planes are parallel This condition of stability is generally satisfied in any arrangement which satisfies the other conditions of stability It must not be overlooked though it is very unlikely to give trouble The corresponding trajectory or curve of oscillation is independent of the velocity, the actual time rates of oscillation and decay being proportioned to the velocity

In the slow oscillations the variations of velocity in the line of flight are a predominating feature. The trajectory is wave-like, the crests of the waves being more pointed than the troughs, and the descending parts steeper than the ascending ones This is evidently the type of oscillation studied by Mr Lanchester One condition of stability is that the front plane (or planes) must be inclined at a greater angle than the rear ones The second condition depends on the type of machine

The terms "monoplane" and "biplane," as usually defined, refer to the question of whether a machine has not or has superposed planes According, however, to a property which I call the principle of independence of height, this distinction does not affect stability to any appreciable extent The important point is whether the weight is sustained partly by the front and partly by the rear planes, as in certain Voisin machines, or is wholly supported by the front planes, the rear ones acting merely as a tail in the neutral position. For a monoplane with neutral tail the condition of stability takes the form given by Lanchester, when the necessary substitutions have been made by making use of the condition of equilibrium. The reason why Lanchester's method leads to a correct result is to be sought in considerations of the peculiar nature of the oscillations, and in especial in the relative smallness of their modulus of decay For a machine of the Voisin type, with sustaining surfaces arranged tandem, the condition of stability is nearly as simple, and certain modifications are sufficient to cover the case when the propeller thrust does not pass through the center of gravity provided that this thrust is constant.

A very convenient plan in such cases is to suppose the actual machine replaced by an equivalent monoplane, with neutral tail, although if the inclinations of the planes be varied for vertical steering the equivalent monoplane will be changed.

The most remarkable result, however—and Mr.

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* Nature

Harper was the first to point this out to me—is the important effect on stability of the direction of motion in the vertical plane. Longitudinal stability falls off rapidly when the aeroplane begins to rise, even if other things are constant. A monoplane would, under theoretical conditions, become unstable when ascending at an angle to the horizon of less than twice the angle of attack (or indication of the main plane to the line of flight)

The effect of head resistance is to increase the stability, and a further increase occurs if the thrust of the propeller, instead of being constant, decreases when the velocity increases By the use of three planes instead of two, an additional increase of stability can be obtained On the other hand, if the aeroplane be gliding downwards the longitudinal stability is greater than in horizontal flight

I think the above conclusions indicate a source of danger which may possibly have led to mishaps when aeroplanes have risen too rapidly in the air

Capt Ferber's investigations, on the other hand, refer mainly to the stability of a single aeroplane as dependent on fluctuations in the position of the center of pressure consequent on variations of the angle of attack He assumes Joessel's formula, introducing two arbitrary constants in place of the numerical coefficients The difficulty I have several times pointed out is that, if a plane is turning over, its rotational motion may affect the position of the center of pressure, as well as possibly the resultant thrust, and no experimental information is apparently available on this point For this reason the use of narrow aeroplanes is to be recommended, stability being the other Moreover, the theory of narrow aeroplanes gliding at small angles affords the simplest introduction to a general study of aeroplane stability, just as geometrical optics in which aberration is neglected affords an introduction to a general study of lens construction It is to be remembered that both the symmetrical and asymmetrical oscillations are determined by equations of the fourth degree, each in the form of a determinant of the third order containing the dynamical constants and resistance co-efficients, and when this determinant has been expanded, four conditions of stability have to be satisfied one being Routh's discriminant $BCD - AD^2 - EB$ shall be positive Fortunately, for purposes of approximation, $CD - EB$ may be substituted for the last in many of the systems occurring in aviation It will thus be seen that stability is a very complicated problem, and that approximate methods are essential

Asymmetric stability is far more difficult of investigation than symmetric It is necessary to take account of the separate effects of straight or horizontal aeroplanes, vertical fins, and bent up or V shaped planes The late Capt Ferber's solution is based on the substitution for the actual planes of their projections on three co-ordinate planes (p 46 of his paper) Unfortunately, even assuming the sine law of resistance, this substitution does not seem to give even the correct first approximation which is all the author claims In particular, if the aerodrome is rotated about any axis in its plane of symmetry, couples are set up on the main aeroplane which have an important effect on the stability, but are apparently not included in his scheme. The final result is a biquadratic with one root equal to zero, and Capt Ferber regards an aeroplane as stable when it describes a helix, whereas such an arrangement should really be regarded as lacking in stability The couples in question are taken account of by Lanchester, who uses what he calls "aerodynamic and aerodromic radii" to represent their effects. For a narrow aeroplane gliding at a small angle, the effect depends on the moment of inertia of the area of the plane about the vertical plane of symmetry A horizontal tail of negligible lateral dimensions does not affect the asymmetric stability

To secure stability, recourse must be had to vertical fins, or to bent up aeroplanes or aerofoils The effect of vertical fins (neglecting "wash") depends on their areas, and the first and second moments of these about the axes, and in studying them it is necessary to have recourse to the "principle of parallel axes The sections in "Lanchester on 'fin resolution' practically embody this principle, but are a little difficult to follow, they suggest the path taken by an explorer who had not a compass to guide him to the mathematically direct road in the form of the principle in question His conditions of stability seem reasonable deductions from the hypotheses he makes, but the conclusions must not be regarded as final Both the necessary and the sufficient conditions of stability are really far more complicated, and it is highly improbable that the problem could have been carried much further without the elaborate use of analysis which I have found necessary, and the assistance of an independent calculator, which Mr Harper has kindly provided The only way of proceeding was to calculate the co-efficients in the biquadratic for particular arrangements of fins and planes, starting with the simpler ones and passing to more complicated ones when one has become thoroughly familiar with the different terms and their meanings

For an aeroplane with one vertical fin only, the conditions of asymmetric stability require that the center of pressure of the fin should be slightly in front of the center of gravity of the machine, while at the same time it should be at a height above the center of gravity large compared with its distance in front Two of the conditions of stability are difficult to reconcile with the conditions of equilibrium the difficulty increasing as the velocity increases and the angle of attack diminishes, moreover they are inconsistent unless a certain relation holds between the radii of gyration of the machine and of the main supporting surface It is doubtful whether this condition would be consistent with practical requirements

The failure of practical aviators to obtain automatic stability may be due in no small measure to the number of conditions that have to be satisfied A vertical fin in front might satisfy one condition of stability, and introduce instability through another condition, while a similar fin at the back might satisfy the second condition and introduce instability through the first In either case the impression produced would be that the device secured automatic stability, but that such stability was a hindrance rather than a help the correct interpretation being that the conditions of stability had not been sufficiently investigated By abolishing the fins the aviator would obtain a machine with defective stability, i e, with one or more roots of the biquadratic vanishing, and would find it easier to maintain his balance by artificial control than in the previous unstable arrangement

Of arrangements with two fins, the cases have been considered where both fins are at the level of the center of gravity, where one is above, and where both are above The conditions of stability assume various forms, but there is one arrangement which appears to possess an exceptionally wide range of stability, and I have made provisional application for a patent in this connection

A machine such as the Voisin type, with two planes of considerable span at different angles of attack, is more stable than one with a single sustaining system and the difference is equivalent to a variation in the arrangement of the fins which is easily calculated

The asymmetric oscillations of an aerodrome do not separate into two kinds, of long and short period like the symmetric ones As a general rule the biquadratic has one root determined approximately by the first two terms representing a quick subsidence, one root determined by the last two representing a slow subsidence, and a pair of roots determined by the middle terms representing a damped oscillation

The inclination of the flight path to the horizon has a considerable influence on the asymmetric stability In several instances we found that instability occurs when an aerodrome is descending at an angle to the horizon the tangent of which is double that of the angle of attack of the main planes Other arrangements become unstable when rising at more than a certain angle, in the best arrangement referred to above the stability is practically independent of the inclination As the symmetric and asymmetric oscillations of an aeroplane are independent it is important that it should preserve its asymmetric stability even when it is not in longitudinal equilibrium The dependence of stability on inclination affords a very simple and likely explanation of certain "vagaries described on pp 342, 343 of Lanchester's "Aerodonetics, account would, however, have to be taken of accelerations of the center of mass in an exact comparison of theory with observation

Bent up or V shaped wings lead to much more difficult analysis, and it appears that their effect is not exactly equivalent to any combination of vertical fins except in certain cases A pair of stabilisers' or small planes which may be fixed at the extremities of the main aeroplanes at an angle of say 45 deg, is equivalent to a single raised vertical fin if the planes of the stabilizers are parallel to the line of flight

Mr Harper has worked out the asymmetric stability of the Antoinette type with a single pair of bent up supporting surfaces The conditions of stability are satisfiable by furnishing the machine with a tail of suitable length, or by raising the dihedral angle of the V shaped wings above the center of gravity

I should like to direct attention to the importance of eliminating the personal element in experimental tests of aeroplane stability, by the use of models The possibility of long distance flights by skilled aviators having been demonstrated, there is not so much point in repeating these verifications as in extending our knowledge in other directions, and finding how far the element of skill can be dispensed with by effecting improvements in aeroplane design

The stability of dirigibles opens up another field of study on which we hope to do something

Owing to the attention now given to aeroplane construction, it appeared desirable to give, in the present article, an advance account of investigations which may not be ready for publication in extenso for some time to come

The Aeronautical Journal for January, 1910, includes a short abstract, illustrated by badly executed diagrams and containing numerous uncorrected printers' errors, in which the symmetric stability of a single-surfaced aerodrome without tail is made to depend on a cubic instead of a biquadratic equation This result is obtained by the very doubtful method of 'assuming V to be constant for a short period,' that is, neglecting fluctuations in horizontal velocity Owing to this assumption the conclusions reached may perhaps represent the conditions that the machine may be stable with reference to the shorter oscillations, but not with respect to the longer ones, and the inference that a machine can be much more stable at moderate velocities than is generally supposed must not be regarded as conclusive

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THE REMARKABLE CONDUCT OF A DROP OF MERCURY.

It has been known a passably long time already that lower organisms that are capable of independent movement, such as amœbæ, infusoria, bacteria and others, are attracted by certain chemical substances. For instance, fill a capillary tube with a weak solution of chlorate of potash or of peptone and put into it a drop of mercury in which bacteria are moving; after a few seconds these will be seen hastening to the mouth of the tube where they will all have assembled. The amœbæ and the naked little masses of jelly (plasmodia) of the myxomycetes (mucous fungi) creep in their peculiar way by stretching forth their arms or feelers toward the stimulant. This faculty of these organisms of being attracted by certain substances is called chemotaxis. Chemotactic susceptibility is evidently an advantage for the creatures in question as it leads them to good nourishment and keeps them near it.

And very recently an eminent physiologist made the discovery that a drop of mercury can make very similar movements. The starting point of his observations was afforded by the experiment made by Paalzow in 1858. The latter put a drop of mercury in a little flat vessel, over this drop he poured diluted sulphuric acid and then laid a small crystal of bichromate of potash immediately beside the mercury The result was a periodical change in the shape of the drop of mercury which alternately approached the crystal, while flattening itself in front, and receded from it. This occurrence was provoked by the fact that the bichromate of potash, aided by the presence of the acid, oxidized that portion of the surface of the drop of mercury turned toward it and thus diminished the tension of the surface of that side of the drop As soon as the peroxide of mercury, which had been produced, dissolved in the sulphuric acid the surface of the mercury became metallic again and its tension increased In the first instance the mercury flowed toward the crystal, in the second it sprang back

In a recent number of the Archiv fuer die Gesammte Physiologie the professor explains his application of this experiment Through appropriate manipulation he imparted to a drop of mercury the faculty of real locomotion. One of the most successful forms of his experiment was this· he put a drop of mercury in a suitable glass dish of which the bottom was perfectly level; then he poured in a sufficient quantity of diluted nitric acid and laid a little piece of bichromate of potash at a distance of several centimeters from the drop of mercury on the bottom of the dish The yellow solution of the crystal began to spread itself in a circle and as soon as it reached the drop of mercury the latter with a curt tremor began to recede and then dashed straight to the crystal which it reached in a few seconds In the liveliest manner it repeated the twitching movements already described If in consequence, the crystal moved away in any direction the drop pursued it, receded and approached, again and again, with a movement of mingled leap and glide, which stretching forth long tentacles and quickly drawing them back again This lively play leads an observer to think that these movements are those of a living organism They last until the crystal is consumed or the drop has accidentally moved too far away from it These remarkable phenomena may be considered as adequate support of the view held by the botanist Berthold, the physicist Quincke, and the physiologist Verworn, that the amœboidal and related movements are the result of changes in the tension of the surface of the living substance Obviously, though, there are still other conditions which can vary largely the movements of the living prototype.

SCIENCE NOTES.

The great heights which balloon artillery must be able to reach necessitate an extension of the range tables and so photographic reproductions of the flight of shot, although affording little information as to velocity are of particular interest Two photographs are published in the Phys Zeitschr in connection with an article by F Neesen, the first showing the path of a shot which emits smoke the second showing the end of the flight of five luminous shot from a mountain gun The latter photograph was, of course, taken in twilight, the path is much more clearly defined in this plan than with the smoke shot and there is the additional advantage that the paths of several shot can be shown on the same plate, also information is given with respect to the direction of the axis of the shot and as to its oscillation

During the opposition of 1909, J C Sola made some observations of Mars at Fabra Observatory, which he discusses in Comptes Rendus A double equatorial of 0 38 meter aperture was used, with a magnification of 450, and sometimes 550 The satellites Deimos and Phobos could be followed. The chief conclusions derived are (1) The main topographical outlines remain constant (Sola has observed Mars since 1890) The small details vary, doubtless owing to cloud and, perhaps, vegetation (2) The tonality is very changeable in the dark regions but practically invariable in the light regions From this it is inferred that the clouds are of similar color to the "lands" or that the "lands" are always covered with snow In general, the details of the south hemisphere grew darker and more plentiful with the diminution of the southern snows, that is with increase of temperature Syrtis Major, faint and scarcely perceptible in August, was dark and well defined in October The canal Bathys was seen during this apparition

The problem of the rotation of Mercury is one of considerable astronomical importance First made the subject of more or less violent discussion by Schiaparelli, the problem recurs almost annually One of the more recent discussions is to be found in the Comptes Rendus by R Jarry Desloges The paper contains reproductions of sixteen drawings of Mercury, viz, eight by G. Fournier, and eight by V Fournier, from which the author infers that the rotation period is long, probably equal to the planet's time of revolution The drawings were made on the Massegros (altitude 900 meters) with a refractor 0 29 meter aperture, on evenings September 15-20, 1909, about half the planet's disk being illuminated. They show a very few dark shaded streaks, two or three branching from the central region, one parallel to the southwest limb, and one cutting across the north cusp. A dark dot is shown on some of the drawings in the southeast, one observer placing it at the intersection of two streaks A dark region is indicated near the equator The south horn is sometimes shown rounded or shaded There is fair approach to agreement between the drawings of the two observers considering that the objects delineated are at the limits of visibility. Jarry Desloges remarks that in the short moments when the images were less unsteady than usual, the dark regions on Mercury appeared as dark as the average tint of those on Mars; and the difficulty in rendering details is mainly due to the bad quality of image peculiar to this class of study

Beating wing flight is considered in the Royal Society Proceedings by M F Fitzgerald The resistance opposed to the acceleration of a body immersed in a liquid may be represented by a virtual addition to its mass, without any corresponding addition to its weight A wing flapping in air may shed, or escape from the virtual added mass at will, much as the paddle of a Canadian canoe can slip out of the disturbance it has created during a stroke Hence a heavy body or engine attached to a wing should be capable of supporting itself and the wing in the air in a succession of leaps. For if the whole be supposed initially falling, a sufficiently energetic pull given by the engine, drawing the wing down and itself up could convert the fall of their common center of gravity into a rise, if there were a weightless but massive body temporarily attached to the wing If, when this rise had been started, the mass were shed or escaped from, there would be an interval in which the center of gravity of the whole would continue to rise, during which the wing and body could be replaced in their original relative positions by mutual action between them, wholly internal to their system free except for gravity If at the end of the rise added mass were again picked up, the same might fall to its initial level and velocity. The process thus becomes cyclic, and may be indefinitely repeated The author calculates the power required to carry 1 pound in the case of a "wing" in the shape of a flat circular disk 12 feet in diameter, for various values of the ratio of the additional virtual mass to the weight The weight carried per horsepower is a linear function of A, and amounts to 34 pounds per horse power when $A = 1$ It varies directly as the rate of flapping

ELECTRICAL NOTES.

According to a statement issued by the Siemens-Schuckert Company of Berlin, the felling of trees by means of wires heated by electric currents, which has been described in various newspapers, cannot be accomplished in a practical and economical manner, for the following reasons The wire, to cut effectively, must be very tightly stretched and it is therefore very liable to rupture, in consequence of its high temperature The red hot wire carbonizes the wood, and the charcoal, if allowed to accumulate, protects the interior parts from the heat of the wire. In order to remove the charcoal, the wire must be roughened and moved to and fro lengthwise, so that the operation is still a sort of saving, and the motion and roughening increase the liability to rupture.

The effect produced on the form of an alternating current by introducing a selenium cell into the circuit has been investigated by A Pochettino and described in Accad Lincei, Atti. The results are given, together with curves, for different types of cell. In nearly all cases the wave-form is altered, the area inclosed by one half of the curve being diminished with respect to the other, and the ratio between the difference in areas contained by the two half waves, and the greater of these, which Pochettino denotes by R, is a measure of the rectifying power of the cell. The value of R varies from 0 06 for a cell with Al electrodes to 0 30 for a Kohl cell of old construction, and in general diminishes with increase in voltage, or decrease in resistance, external influences, such as heat or light, which reduce the resistance also diminishing R.

When an electrolytic cell of the aluminium type, containing a solution of a borate as electrolyte, has been in continuous operation for some time, an objectionable deposit is liable to be formed on the plate In an invention recently patented in this country and in England this deposit is in great part suppressed, end its injurious effects are reduced, by the addition of tartrates to the electrolyte; this also improves the character of the film, in cutting down the leakage current and in raising its critical or breakdown voltage, besides reducing the resistance of the electrolyte The solution may be made by mixing 6 parts of boric acid and 1 part of tartaric acid and then approximately neutralizing the mixture with ammonia or other alkali, or a tetraborate may be used instead of boric acid. In some cases, it is preferred to add also about 10 per cent of glycerin, and, in a modification of the invention, the acidity thus produced is neutralized or partly neutralized by again adding alkali.

The city of Naples is taking measures to secure a large amount of current for light and power purposes from a hydraulic plant which is to be located at 55 miles distance at the sources of the Volturno stream. These sources are received in a number of reservoirs and the hydraulic work will comprise a 2 mile flume and a set of three penstocks in order to supply the turbines The station will be located on the Volturno stream, and it is thought that it will furnish 10,000 or 15,000 horse power Alternators working on the three-phase 5,000-volt system will be used, and a set of transformers will raise the voltage to 45,000 for use on the overhead power line leading to Naples In the city the line is received in a transformer station in which the tension is lowered so as to feed the city mains These are to be underground within the city limits, but it is also intended to run several overhead lines for use in the suburbs. In connection with the transformer station there will be erected a steam plant which serves as a standby and will be able to give about 6,000 horse-power, so that the city will dispose of a total of 16,000 horse-power for the new plant. It is also intended to use a second fall on the Volturno stream which lies below the preceding, so that the total amount will be increased to 20,000 horse-power.

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WITH AN INTRODUCTION BY

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The present work presents twenty points of view, all of them interesting and no two quite alike. Each essay is 2500 words in length. The reading of one essay does not involve the reading of the entire work, yet the entire book gives a comprehensive view of what the layman wishes to know about the Fourth Dimension No abstract mathematics will be found in the volume. The essayists endeavor to explain the Fourth Dimension both by imagining the effect of transporting an ordinary third-dimensional human being into fourth-dimensional space and also by explaining a third-dimensional man's possibilities in one and two dimensional space

Professor Manning, the leading American authority on the subject of the Fourth Dimension, contributes an introduction in which he explains how the concept of the Fourth Dimension gained mathematical prominence, and swiftly reviews the work that has been done in the field. He has also edited the essays and supplied explanatory footnotes where required.

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TRADE NOTES AND FORMULÆ.

Modeling Wax (for Making Fruits, Leaves, Etc.)—10 parts white wax, 1.5 parts mutton fat, 1.5 parts dark rosin melted together, add 1 part of cinnabar (vermilion), stir, take from the fire, pour into rod shaped tin molds where it must be stirred until it sets (Use also other non poisonous colors.)

Embossing Wax.—Modeling wax for rough work.—A mixture of 3 parts turpentine, 5 parts wax, and some olive oil or hog's fat; to make it non transparent add red lead or cinnabar. For finer work, 100 parts pure white wax, 132 parts pure hog's lard, 132 parts black pitch, 66 parts cinnabar or vermilion.

Preservation of Antique Wall Paintings.—Impregnate them with a solution of paraffine. In the case of fresco and stereochromic paintings, defective spots are to be gradually saturated with silico-fluoric acid and water glass, then painted with colors (which may be applied by means of water glass) and then treated with a fixative and finally impregnated with paraffine

Preservation of Leather.—Melt 3 parts of common washing soap with 1 part of palm oil and add to it 4 parts of ammonia soap (obtained by saturating oil soap with carbonate of ammonia) and 1.75 parts of a tannin solution, containing 9 to 16 parts of tannic acid dissolved in 4 parts of water The unguent thus obtained can be kept for a long time in well-corked stone vessels and should be used only in such quantity as the leather will conveniently take up.

Substitute for Bristles and Whalebone.—The fibers of a suitable plant (piassava, alpha grass, etc) are joined together by means of a suitable adhesive. For the latter purpose use solution of silicate of soda alone or mixed with heavy spar, felspar or chalk, or any kind of gum, glue, shellac, etc The cemented mass is cut into strips and after drying is given a coating of celluloid, glue, etc. To make the mass water proof, it should be given a coating of rubber solution, copal, or similar resins. Finally, the composition is covered with metal foil, silk, cotton linen, etc.

Production of Carmine.—1. 125 parts of finely pulverized cochineal is boiled with 5,000 parts of water for 15 minutes, and after adding 30 parts powdered alum, allowed to stand hot until the fluid is fairly clear, then quickly strain it through a linen cloth. After 24 hours, pour it off from the separated carmine (40 to 50 parts), and in another 3 days it will again yield some carmine, but of inferior quality. 2. 500 parts of cochineal powder is boiled for 15 minutes with 15,000 parts of water, 30 parts pulverized cream of tartar added and boiled for ten minutes; 15 parts of powdered alum boiled for 2 minutes. Allow to settle hot, expose the clear fluid in shallow glass dishes in a very light place and the carmine will be deposited as a fiery red powder

Cigar Perfuming Box.—Melilot clover 200 parts, tonka beans 50 parts, oil of roses 1 drop (clover is cut very evenly fine, passed through a very fine sieve and thereby freed from dust) The tonka beans are first cut into fine strips, like nudels, then across into small cubes and mixed with the clover Finally, the genuine rose oil is dissolved in alcohol perfectly free from fusel, and the above mixture sprayed as evenly as possible with the fluid. Other perfumes may also be sprayed on the clover-tonk bean mixture: 1. Valerian tincture 200 parts (obtained by allowing 1 part of valerian root to stand 8 days in 8 parts of fine alcohol, frequently shaking and finally pressing it out); tonka bean tincture 200 parts (20 tonka beans in 180 parts of fine alcohol); benzoin tincture (50 parts gum benzoin dissolved, with shaking, in 1,000 parts of alcohol and filtered). 2. Valerianic acid 10 parts, benzoin tincture 100 parts, alcohol 1,900 parts, acetic ether 40 drops, butyric ether 10 drops. 3. Vanilla tincture 8 parts (1 part vanilla, 5 parts of fine spirit), tincture of valerian 15 parts, butyric ether 15 parts, spirits of niter 4 parts, alcohol free from fusel oil 1,000 parts.

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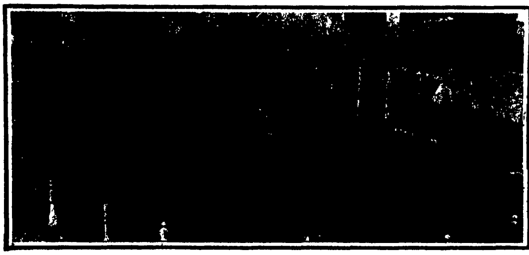
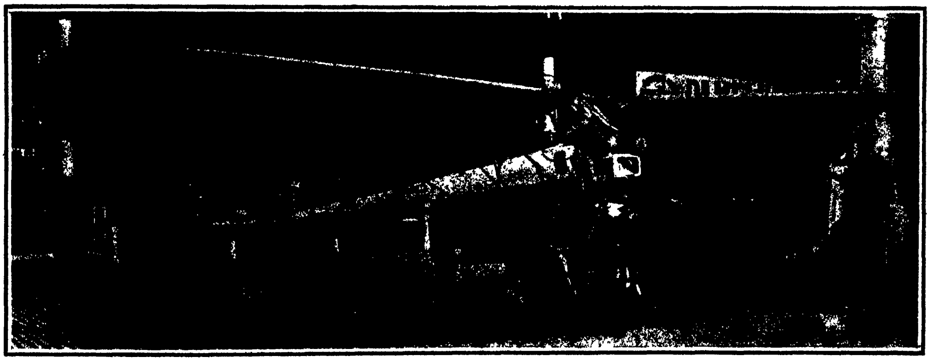
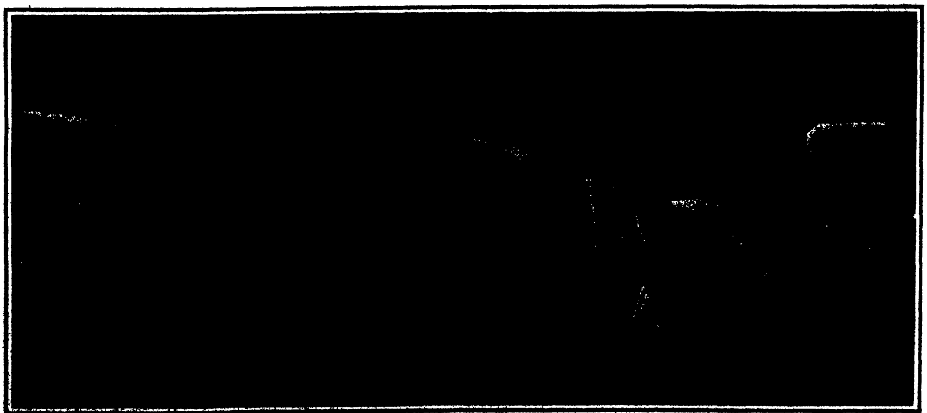


THE GEORGE AND JOBLING BIPLANE, WHICH RESEMBLES THE CURTISS IN SEVERAL RESPECTS

MESSRS. SHORT BROS. MODIFIED WRIGHT MACHINE WITH FIXED CRUCIFORM TAIL WHICH WON THE £1,000 PRIZE FOR THE FIRST MILE FLIGHT BY AN ENGLISHMAN.



THE LE BLON-DELAGRANGE HUMBER MONOPLANE WITH TUBULAR WOODEN BODY.



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THE OLYMPIA AERO EXHIBITION AT LONDON.—[See page 231.]

THE ELECTRIC FURNACE.*

PROGRESS IN THE MANUFACTURE OF IRON AND STEEL.

BY P. M'N. BENNIE.

It is to be regretted that an account of progress in the application of the electric furnace to iron and steel production has to draw so many of its data from foreign sources and so little from work done in this country American steel makers have not as yet taken hold of this new metallurgical tool with their accustomed alacrity Concerning the bare half dozen installations here very little is given out as to the metallurgical results attained

At the annual meeting of the American Electrochemical Society last May there was presented an interesting series of papers, abstracts of which appeared in the Iron Age at the time These papers were intended to show the state of advancement at the date of the meeting and revealed the fact that much work and serious investigation are being carried on by many active and intelligent workers in the electric furnace field.

PRODUCTION OF PIG IRON

So far as concerns the production of pig iron by means of the electric furnace, the practical work thus far appears to be confined to two installations, one at the Domnarfvet Works in Sweden, where a furnace designed by Gronwall, Lindblad and Stalhane is used This furnace is referred to in the Iron Age of August 19th, 1909, and is also described more fully in a pamphlet issued by the Department of Mines of the Canadian Government The other installation of importance is located at Heroult, on the Pitt River, Shasta County, Cal where the Noble Electric Steel Company has put down an elaborate plant for mining magnetic iron ore and limestone on the premises, together with a complete plant for making wood charcoal with recovery of by products

The California electric furnace is a type developed after a series of experiments by Prof D A Lyon of Stanford University metallurgist in charge This furnace has already been illustrated and described in the technical journals It may be interesting to note here, however, the latest news with reference to the California enterprise Some difficulty was encountered with the carbon electrodes, of which there are six in the furnace This problem seems to have been at least partially solved, as we are informed that after certain alterations and improvements indicated by previous trials had been made, the furnace was started on a campaign December 13th, and a tap of eight tons of electric furnace pig iron made December 14th. The information is given that the furnace has since been tapped regularly and that no difficulties have thus far arisen

It may be interesting to note the quality of the pig iron produced at this plant The following analyses are given, by which it will be noticed that a very pure product is being turned out, low in sulphur and phosphorus:

	1	2	3	4
Silicon . . .	0.94	0.84	0.98	0.94
Sulphur	0.012	0.037	0.049	0.002
Phosphorus .	0.027	0.022	0.03	0.02
Manganese	0.11	0.03	0.08	Trace
Combined carbon	1.20		4.56	3.25
Graphitic carbon	2.06			

It must not be considered, however, that the accomplishment of making pig iron by the use of an electric furnace contains any menace to existing methods of producing pig iron Even a broad interpretation of the establishment of the new method can only mean that an apparatus has been devised suitable to certain conditions where the older methods would be found impracticable The application of the electric furnace process will therefore find its growth and development in certain restricted localities where conditions favorable to it exist, without the slightest intention of invading those districts favorable to fuel fired furnaces

It is worthy of remark that the analyses thus far published seem to indicate an iron of exceptional quality, so it may be that owing to its peculiar conditions of production, electric furnace pig iron will create a special market for itself Some of the product made by the Noble Electric Steel Company has already been used for castings by foundries at Redding, Cal., with extremely satisfactory results

PRODUCTION OF STEEL

During the past year much progress has been made with electric furnaces as applied to steel production, commercially and metallurgically The application of such furnaces is practically confined to those types developed by such prominent and able workers as Stassano, Keller, Heroult, Girod Kjellin-Colby and Rochling Rodenhauser Each of these types has already been described in more or less detail in these columns, so need not be reviewed here

Of statistical interest, however, and as showing the rapidly widening application of the electric furnace as a metallurgical apparatus upon the commercial scale, it may be mentioned that of the prominent types the following furnaces have already been installed or are in course of construction:

Name	Number
Stassano	12
Keller	4
Heroult	20
Girod	18
Kjellin Colby	12
Rochling Rodenhauser	12

The largest of these furnaces in point of tonnage are those of the Heroult type, one of which has been running for some time at the South Chicago Works of the Illinois Steel Company, and the other, which is just starting up, at the Worcester Works of the American Steel and Wire Company Each of these furnaces is designed to handle from 12 to 15 tons at a heat When it is considered that one of these furnaces working well will handle about 12 heats daily, with a total daily production of 150 to 180 tons, it will be realized that so far as capacity goes the electric furnace has freed itself from the reproach that it is only a plaything Girod has installed a complete steel works at Ugine, where he has two furnaces of 12 tons capacity each, thus running the Heroult type a close second.

The apparent apathy of American steel makers, located as they are in the greatest steel producing country in the world, to a revolutionary innovation which has already gathered considerable momentum abroad is rather unaccountable Our steel manufacturers have seldom been accused of ultra-conservatism, yet among all the electric steel furnaces now listed we make rather an indifferent showing Still it is some satisfaction to know that, even if we have not so many installations to mark our progress, we do possess the largest electric steel furnaces so far in operation Something like 25,000 tons of electric furnace steel was made in the United States in 1909, while the production for 1910 will reach at least 75,000 tons The year 1909 marks the first appearance of the electric furnace product in our steel statistics in substantial quantity A number of the installations now under way and projected may materially increase this figure for 1910

PROGRESS IN FURNACE OPERATION.

Perhaps of greater interest is the technical progress with regard to furnace operation and metallurgical practice In types of furnaces so widely apart as those of Stassano, Heroult and Rochling-Rodenhauser it might be expected that technical problems peculiar to each would be encountered, and such has proved to be the case By reason of the somewhat higher temperature generally attained with electric furnaces, the matter of refractories becomes of prime importance, presenting a problem common to all electric steel furnaces. It is gratifying to record, therefore, that with reference to this problem, a careful choice of refractory materials, coupled with improved methods of application, has resulted in greatly prolonging their life, and consequently reducing the cost per ton for this important item All electric furnaces are basic lined, and it has become almost the universal practice to use a proportion of tar or pitch as a component of the lining mixture; when this is baked in not too slowly good results are obtained. In this respect electric furnaces differ from other steel making furnaces

Another problem peculiar to electric furnaces of the electrode type is the matter of electrodes, the difficulty being intensified in the larger furnaces where the electrodes attain hitherto unprecedented dimensions. The electrodes being made of carbon, and that material presenting unusual difficulties of manufacture with increase of size, it may be said that the chief difficulty with furnaces of the electrode type now rests with the electrodes Here again it is interesting to record that much progress has been made, and that as careful investigation along approved scientific lines is being carried out in several quarters, we may expect to see substantial amelioration in quality and trustworthiness at an early date. When the electrode problem shall have been completely solved, a further important reduction in the cost of making steel in electric furnaces will have been accomplished.

The cost of electric power still remains of considerable moment where melting from the cold state is carried on It should be borne in mind that heat energy electrically developed is not "cheap" energy, when compared with heat energy developed by combustion of fuel This is especially true where electric power is steam generated, that being a roundabout way of using the calorific energy of fuel Its advantage lies, however, in the tractability of electric power, the ease with which it may be controlled, the temperatures of the metallic bath regulated, the high temperature attainable and metallurgical conditions possible with electric furnaces

When, however, it comes to treatment of molten steel, as an operation secondary to Bessemer or open hearth treatment, the electric energy is being used under extremely favorable conditions, for it is found with the larger furnaces that a power consumption of 100 to 150 kilowatt hours per ton suffices Where 50 to 75 tons per horse power-year can be thus treated this item becomes of minor importance

METALLURGICAL PROGRESS

To those conversant with the facts the greatest significance attaches to the metallurgical progress being made Electric steel furnaces present new metallurgical conditions to the steel maker, with the result that a new metallurgical practice is being developed

Hypothesis and theory are following hard upon observed results with electric furnaces These results are throwing light upon things that can occur under certain conditions so practical steel makers would do well to pay close attention to these phenomena, as possibly indicating interesting experiments with existing apparatus, particularly the open hearth furnace

One thing has been conceded to the electric steel furnace, which is that with reference to elimination of oxides, sulphur and phosphorus it has shown ability to rapidly remove these deleterious impurities to an almost unprecedented degree Certain it is that, no matter why, the electric furnace is an efficient remover of certain things considered as undesirable in steel This is one striking characteristic of the new metallurgy improvement in quality by removal of things rather than merely rendering them supposedly innocuous by metallurgical nostrums

An interesting paper on "The Electric Refining of Steel," by F W. Harbord, is given in the Iron Age of August 19th, 1909, which sheds much light on the reactions said to occur in electric furnaces, resulting in the high degree of elimination of impurities, such as oxides, sulphur and phosphorus Doubt has been expressed as to the possibility of hydrogen remaining in steel during the cooling period The results of the tests at Sheffield, where heated ingots were subjected to reduced pressure, emanating gases pumped off and analyzed, should settle that point Moreover, the doubting ones neglect the possibility of hydrogen existing in the combined state as iron hydride It is a fact, however, that nothing is specifically done in electric furnace treatment toward the removal of one other element which has recently been blacklisted by metallurgists. We mean nitrogen. As titanium seems to combine readily with this element, the resulting compound readily entering supernatant slags, the small addition of its ferroalloy would probably be justified by results.

Aside from data published by those interested in the various types of furnaces very little has been made public as to the physical results obtained, particularly with regard to steel charged molten into the electric furnace for final refining and finishing We have no doubt whatever that the trained metallurgists in charge of these installations are finding out things of material benefit under these new conditions of operation. From an authentic source, however, we learn that steel rails have been made from some heats to see what physical characteristics they possess, with results that were surprising, the rails showing extreme toughness, resistance to shock and high quality superior to ordinary rails. Dr. Heroult assures us that for similar analyses the electric furnace product shows approximately 20 per cent. higher tensile strength and elongation than the product of ordinary methods.

One line of manufacture in which the advantages of electric furnaces and their product seem suddenly to have been realised by steel makers is in steel castings. Several of the plants in Europe have been installed for this particular purpose Making steel castings by the open hearth method is at best an expensive, troublesome and uncertain process It is claimed for the electric furnace and with good reason that aside from the improved quality obtained there is a large saving in defective castings these items outbalancing the enhanced cost to such an extent that profits are actually increased Several important installations for this purpose in the United States have been decided upon We are informed from a trustworthy source that the establishment of a plant of electric furnaces, will shortly be announced

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* Iron Age

An interesting innovation has been made at a works in Europe in the Luxembourg District where hot Luxembourg metal is charged into a four ton electric furnace with 2 per cent scrap the entire operation of removing carbon sulphur and phosphorus being conducted in the one furnace The hot metal contains 1 8 per cent phosphorus and 0 20 per cent sulphur the final product being soft steel for castings containing 0 1 per cent and below of carbon with sulphur and phosphorus below 0 02 per cent This looks like duplexing with a vengeance using the blast furnace and the electric as the units This works reports that there is no lack of orders at a profit

Finally an important feature of electric steel furnace progress is the relief held out to existing Bessemer plants which have been facing the necessity of some sort of duplex process or going over bodily to the open hearth We believe that the electric furnace is going to fulfill its largest function as one unit in a duplex process and that the Bessemer plus the electric furnace will be found a better combination than Bessemer plus open hearth also that the open hearth plus electric will be a better combination than two open hearths

FAST AND FUGITIVE DYES.

SOMETHING ABOUT THEIR CHEMISTRY.

BY PROF. OTTO N. WITT.

I HAVE repeatedly called attention to the confusion of ideas which prevails in regard to dyestuffs and the colors which they impart to textile fabrics An old proverb says that many men talk of many things as a blind man talks of colors Color is one of the things which men most often speak of as if they were blind The most absurd statements concerning the difference between fast and fugitive dyes are made by persons who do not know what they mean by the terms fast and fugitive The commonest and most popular conclusion is that all natural dyes are fast and all artificial dyes are necessarily fugitive I have often endeavored to destroy this myth of natural and artificial dyes by showing that there is no real difference between these two classes of dyestuffs and that all dyes are members of the same great family of chemical compounds and all are subject to the same laws It is only a question of time and chance whether a particular dye appears in the market as a natural vegetable or animal substance or as a product of human skill and industry This truth is illustrated by the two celebrated examples of alizarin and indigo both of which are now manufactured and artificial products after having played the most prominent parts as natural dyes during thousands of years But argument and demonstration are wasted on a great many persons who pin their faith on the old fable and even boldly assert that alizarin and indigo the classical examples of fast dyes have lost their virtues since they have appeared in the market as artificial products For not even alizarin or indigo is as unchangeable and dyed in the wool as prejudice

The 'fastness' or permanence of a dye is not a single uniform quality but comprises numerous varieties, and there are very few dyes which possess every variety Permanence is simply the power to resist destructive influences and dyed fabrics are subjected in the course of time to so many different influences that the fastest of dyes may occasionally be injured A drop of nitric acid for example falling on a garment dyed with indigo will instantly produce a yellow spot which cannot be restored to its original color no matter whether the indigo used in dyeing the cloth is of natural or artificial origin But most dyed fabrics are exposed very freely to sunlight which is a more powerful agent than nitric acid Hence the power to resist the action of light is the most important of all varieties of permanence and we will devote especial attention to it

The number of dyes that can be exposed without injury to long continued direct sunlight is exceedingly limited On the other hand there are many dyes which may be regarded as fast in daylight and which may safely be exposed to daylight and even to sunlight as freely as the weavers of the dyed fabrics are accustomed to expose their own persons The most permanent of dyes is somewhat affected by bright and continuous illumination during months and years but a dye that fades in a few days or hours of exposure is properly classed as fugitive

We see therefore that there is no difference in kind but only a difference in degree between fast and fugitive dyes Both are affected by light but in one case the effect produced is so small that it may be disregarded while in the other it is sufficiently great to constitute an injury The extent to which a dye is altered by a given exposure to light depends upon the structure of the molecule of the dyestuff Increase of knowledge of the chemical constitution of dyes will bring a clearer understanding of the laws which govern the resistance of dyes to the action of light and even now we are able to draw some correct theoretical conclusions in this difficult field of chemistry

In order to draw such conclusions however we must endeavor to obtain an insight into the nature of the action which light exerts upon colored substances Here unfortunately the views which prevail even among men who have made a special study of dyes are so confused that it may be of service to suggest that every orderly investigation of natural phenomena should commence by clearly indicating the object of investigation

We know that light destroys a dye according to its character rapidly slowly or (practically) not at all We desire to know just what light does to fugitive dyes and what fast dyes do to light When a walnut is struck with a wooden mallet the nut is broken but when an iron anvil is struck with the same mallet the mallet is broken We continue to see all the objects and therefore we understand what has taken place but if the nut simply vanished in the first experiment and the mallet vanished in the second the phenomena would appear very mysterious

Light corresponds to the mallet impelled by muscular force It is a form of energy which is applied to the molecules of the dyestuff The walnut and the anvil represent the fugitive and the fast color the passive objects of which the former is destroyed by the applied energy which the latter successfully resists We wish to know how each of these results is brought about

To this question the existing literature of the subject (with the exception of certain articles of mine) gives a very inadequate reply Some writers assert that light oxidizes others that it reduces dyestuffs It is evident however that no form of energy can produce exactly the same effect upon all dyes because no two members of this great family of chemical compounds agree precisely in molecular structure Sunlight furthermore is not a single form of energy but includes vibrations of very different wave lengths which can be traced into the ultrared and ultraviolet regions far beyond the limits of the visible spectrum The effects produced by the ultrared rays are chiefly thermal but the chemical power of the rays increases steadily from the red to the violet end of the spectrum while in the ultraviolet region we find rays that can be detected only by their chemical effects The power of ether vibrations to cause chemical transformations is easily comprehended when we remember that the atoms of a chemical molecule are also in vibration By the influx of additional energy this intramolecular vibration is increased often so greatly that the molecular combination is destroyed In all chemical compounds the absorption of energy from without necessarily increases the tendency to dissociation

The colors of all bodies are produced by selective absorption of the light that falls upon them A dyestuff like any other colored substance absorbs some of the rays of which white light is composed and reflects or transmits the remainder But this remainder is not white light The eye detects the absence of the wave lengths that the dye has absorbed and the sensation of color results

Dyes and other colored substances can be studied and distinguished with the utmost precision by means of their absorption spectra A glance through the spectroscope shows exactly which wave lengths are absorbed by the dyestuff And when we find that no two dyes show the same absorption spectrum we understand that no two dyes are really alike no matter how closely they resemble each other when regarded superficially The results of this great diversity of interaction between light and dyestuffs cannot be summed up in a single word oxidation or reduction The majestic simplicity of nature is not quite as simple as that

The error is caused by ignoring the essential part of the phenomenon The sensation of color is produced by those rays that are not absorbed by the dyestuff but the dye is destroyed by the rays that are absorbed This absorbed light is energy which cannot be destroyed but must reappear in one form or another What becomes of it? Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus

HUMAN NATURE AND CLOTHES.

CLOTHES A Human Nature Study was the subject of a lecture delivered before the Selborne Society in the Burlington Gardens Theater by Mr Wilfred Mark Webb the honorable general secretary Mr Christy, who presided in the absence of Lord Avebury said the subject was one which Mr Mark Webb had made his own We were all interested in clothes for few things touched us more closely

Mr Webb said he proposed to show by lantern slides what interest there could be got out of clothes when investigated as a nature study The earliest garment was probably the shawl which was also used as a petticoat Make rows of stitches up the middle of the petticoat, give one long cut between them and you got a pair of trousers The hat band on a man's hat was an interesting survival of the fillet with which the shawl was bound on the head The Scotch cap the Bishop's miter, and the little boy's sailor hat with their tails and the bonnet strings could be referred to the same origin The little bow in the hat lining, at the end of the lacing, had its origin in the time when there were no one-eighth sizes and head coverings could be laced in or let out according to the size of the wearer's head Men when in uniform to this day wore their feathers on the left side because when plumes were first used and men drew their swords more frequently they did not want in flourishing them to get them mixed up with their feathers The cocked hat probably had its beginning in the age when hats were made so large that people took to looping them up temporarily and afterward the habit became permanent The helmet of the modern fireman had hardly altered since the ancient helmet of the Greek The cockade had been traced back to the old hood which as it grew longer was tied over the head and the fringed end drooped over like a cock's comb

The ordinary coachman of to-day was the gentleman of the middle of last century the flunkey wore the knee-breeches of the George III period and the page-boy's three rows of buttons came from the early reign of Queen Victoria The groom's belt was for his mistress to hold on by when she rode pillion The judge's wig with a hole in the top was not for ventilation but referred to the time when judges were sergeants-at-law who were members of the Order of the Coif

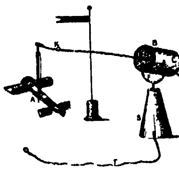
In a French patent recently issued to O Serpek a process is described of manufacturing pure alumina In this process pure alumina is obtained by heating bauxite or other raw material to a temperature at which impurities are volatilized a current of air or other gas being maintained to completely carry away the volatile products Or carbon may be added and the heating effected in the presence of nitrogen or a gas rich in nitrogen which at a temperature above 1 600 deg C causes impurities to volatilize and gives aluminium nitride the latter being transformed into pure alumina with the liberation of ammonia as a valuable by-product by treatment with water under pressure If iron be present it may be removed from the nitride by means of dilute acids or chlorine or in other manner Even clays may be economically treated by the process and give a product pure enough for use in the preparation of aluminium.

NOVELTIES IN TOYS.*

SOME INTERESTING FRENCH INVENTIONS.

THE VIROPLANE

The viroplane is a new and ingenious toy, the operation of which is based upon the gyroscopic phenomenon known as precession. When a solid of revolution which is rotating rapidly on its axis is subjected to the action of a couple of external forces, it assumes a second rotary movement, called a movement of precession, about an axis parallel to the direction of the forces. Thus the axis of a spinning top under the influence of the couple consisting of its weight acting downward at the center of gravity and the reaction of the floor acting upward at the apex of the peg describes a cone whose axis is the vertical line which passes through the fixed point, i. e., the apex of the peg. In the viroplane a flywheel [illegible] is inclosed in a tin cylinder B. The common axis of the flywheel and the cylinder is prolonged outside the cylinder by a steel rod T about [illegible] inches long, from the end of which is suspended a little aeroplane A. The whole is supported by horizontal bearings C at a point between the flywheel and the center of gravity of the whole system, so that the aeroplane rests on the floor when the flywheel is not rotating. The bearings C are attached to



THE VIROPLANE

the prongs of a fork F, which can be caused to rotate about its vertical axis D by a friction device R, which is operated by twisting a button at the free end of the spiral spring S. The flywheel is caused to rotate by turning the crank M, the movement of which is transmitted to the flywheel by the multiplying train of gearing G.

The aeroplane, suspended from the other end of the rod, is affected by two movements of precession of the flywheel, which are produced respectively by the constant vertical couple due to the weight and by a variable horizontal couple due to the rotation of the fork at the will of the operator. Each of these couples produces at any given instant a perfectly definite movement of precession. Thus by twisting the button from left to right the aeroplane is caused to rise from the floor, while it sinks when the button is turned in the opposite direction. If the button is not touched and the force of gravity is allowed to act alone, the aeroplane soars in a circle at a nearly constant height. The couple due to the weight, and consequently the mean velocity of the aeroplane in this movement of precession, can be regulated by moving a sliding weight K on the rod T. The aeroplane is suspended from one of its highest points and is therefore in stable equilibrium. As its center of gravity is considerably lower than the point of suspension, it is subjected, when both couples are in operation, to additional couples due to inertia, which cause its bow to tip upward when it is rising and downward when it is descending, in the manner of a real aeroplane. In order to make the viroplane a game of skill as well as an interesting scientific toy, several little flags are placed along the path of the aeroplane to serve as marks to be hit or obstacles to be avoided. The jury of the Lepine exhibition of toys has very properly awarded a grand prize to this ingenious and interesting invention.

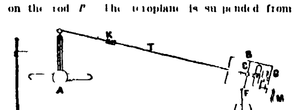
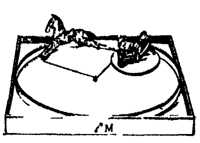


DIAGRAM OF VIROPLANE

A MECHANICAL CIRCUS

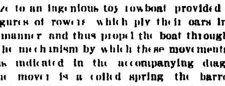
In a new French mechanical toy the performances of the circus are imitated by means of very simple apparatus. The floor of the circus is the false bottom of a shallow square box. Beneath this false bottom is a pinion, which is turned by a crank (M) at the side of the box and drives a large horizontal toothed wheel, the axis of which protrudes through the floor of the circus at its center. Two radial wires attached to this axis serve as supports for the feet of a horse or a human figure. In the illustration the horse appears to draw a disk on which two clowns are seated and which presses against the rim of the circus and consequently revolves on its own axis as it is drawn round the ring. A clown and a wheelbarrow may be substituted for the horse and disk.



MECHANICAL CIRCUS

A TOY ROWBOAT THAT IS REALLY ROWED

The jury of the Lepine exhibition has awarded a grand prize to an ingenious toy rowboat provided with jointed figures of rowers, which ply their oars in the orthodox manner and thus propel the boat through the water. The mechanism by which these movements are effected is indicated in the accompanying diagram. The prime mover is a coiled spring, the barrel of which carries a pin M, which, by means of a driving rod, moves a series of jointed parallelograms ADOC, etc., equal in number to the rowers. The bases of the parallelograms are connected with the rod of a piston moving in a horizontal cylinder H, which has an orifice, the size of which can be varied by moving the lever L. The cylinder thus acts as a brake or escapement and allows the speed of the rowers to be regulated by means of the lever. The oarsman's body is pivoted at C and his oar at B. By the connection of the levers OC and OB and the combination of the movements of transition and oscillation, the blade of the oar is compelled to move in an oval curve, dipping into the water when moving backward and emerging when moving forward.



TOY ROWBOAT

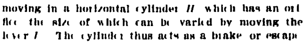


DIAGRAM AND MECHANISM OF TOY ROWBOAT

A PRACTICABLE TOY STEAMBOAT

Desvaux of Paris has constructed a practicable toy steamboat which is driven by a very well constructed engine and can attain a speed of ten miles per hour. The hull of polished mahogany is 50 inches long, has a maximum width of about 7 inches and weighs about 4 pounds. The weight of the boat complete with its machinery is between 11 and 12 pounds. A peculiarity in the construction of the hull is the presence of a diminutive keel which is deepest at the bow and dwindles to nothing at the stern. This construction diminishes the draft at full speed without entirely sacrificing stability and, in connection with the concave form of the forward part of the vessel, it allows the engine to be placed low enough to make the shaft nearly horizontal.

The machinery is sufficiently interesting to deserve detailed description. Its total weight is only 5¼ pounds, and the engine, which makes 1 400 revolutions per minute and develops 1/12 horse-power, weighs only a trifle more than one pound. The engine (Fig. 3) occupies a space of [illegible] x 3 x 1¼ inches. It has four cylinders, which are arranged in groups of two in respect to the admission of steam by means of the slide valve. The cranks of the two cylinders of each group are opposite each other and at right angles to the cranks of the other two cylinders. Hence the engine has no dead point, so that the flywheel can be omitted and weight saved. The cylinders are single acting, the steam exerting pressure only on the anterior or upper faces of the pistons. In the position of the pistons shown in Fig. 3, the pistons of the cylinders of group A are at the middle of their course. The piston b is being forced downward by the pressure of the steam and its crank, being horizontal, is exerting its maximum torque on the shaft, while the piston a, pushed upward by its crank, is expelling the exhaust steam from its cylinder into the atmosphere. At the same instant the pistons of group B are at the ends of their course, d beginning to act on the shaft and c beginning to expel exhaust steam. Hence only two pistons, one of each group, act on the shaft at any given instant, and while one of these is at the beginning or end of its course and exerting its minimum torque, the other is at the middle of its course and is producing its maximum effect.

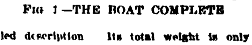


Fig. 1.—THE BOAT COMPLETE

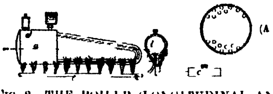


Fig. 2.—THE BOILER (LONGITUDINAL AND TRANSVERSE SECTIONS)

The boiler (Fig. 2) consists of a reservoir a and eleven tubes which extend horizontally from the lower part of the reservoir to a certain distance and then bend and return to the reservoir near its top. The reservoir is a horizontal cylinder [illegible] inches in diameter. It is provided with valves, blow-off cocks, a steam gage and the other customary accessories of steam boilers. The normal water level is indicated by the dotted line. The upper branches of the tubes are filled with steam.

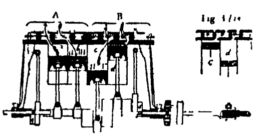


Fig. 3.—THE ENGINE

The fuel employed is alcohol in the form of vapor. The alcohol is contained in a vessel b which is heated by an ordinary spirit lamp c, and the alcohol vapor passes into four tubes d placed horizontally beneath water tubes and the cylindrical boiler, drawing with it a certain proportion of air which enters through the orifice e. The mixture of air and alcohol vapor escapes through orifices at the top of the tubes d in a number of fine jets which, when ignited, heat the boiler so rapidly that the maximum pressure, 71 pounds, is developed in two or three minutes. The flame is then moderated and the speed of the engine is diminished in order to prevent condensation.

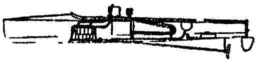


Fig. 4.—ARRANGEMENT OF THE MACHINERY

The organs of control are grouped at the stern of the boat for convenience of operation and to enable a course to be laid correctly for a given point. There is a rod connected with the throttle valve and a lever by which an escape valve can be opened when the pressure becomes too high. (There is also an automatic safety valve, controlled by a spring and set to 85 pounds.) The boat is steered by a rudder of sheet copper, which is placed at the left side of the stern in order to escape the influence of the eddies formed by the propeller. The vessel holds its course very well to a distance of a hundred yards.

This ingenious toy steamboat is very interesting in every way, but it is necessarily much more costly than a sailboat of the same size.

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* La Nature.

THE OIL FIELDS OF THE GULF OF MEXICO.

THEIR GEOLOGICAL PLACE.

BY LIEUT. JOHN C. SOLEY, U. S. N.

LOCATION.—The accompanying chart shows the position and extent of the oil field as located by the reports received during the last five years. The area within which floating oil has been found extends from latitude 26 deg N to 28 deg 0 min N and from longitude 89 deg W to 93 deg W. As the location extends in the direction of the flow of the main current of the Gulf Stream it is probable that the area shown is much larger than the actual area from which the oil escapes. The most active part of the field is about 120 miles south of Trinity Shoal off the Louisiana coast.

History.—The appearance of bitumens in various shapes in the Gulf of Mexico dates back to the earliest history of this country. They have been reported by navigators at different times at different points and in different forms, but the fields of floating oil have attracted little attention though it is believed that they have always existed. In 1543 the companions of DeSoto after his death sailed down the Mississippi and along the coast to the westward and found numerous evidences of the presence of the bitumens. Taking refuge from a storm in a creek they found a scum cast up by the sea like pitch with which they payed the bottoms of their vessels. In 1[illegible]98 a writer says there is found in great quantities upon the coast east and west of the Meschacebe especially after high south winds a sort of stone pitch called by the Spaniards copee; they mix it with grease to make it more liquid and use it as pitch for their vessels. Acosta, the famous author of a history of the West Indies, affirms it to be generated of an oil which empties itself into the ocean in great quantities. The English sent to discover the Meschacebe found it in two places, the sea was covered with the oil or slime which had a strong smell. Another writer says that ambergris or gray amber was found on the coast from Cape Florida to Mexico, said to be a bitumen of naphtha which comes from certain springs or fountains that empty themselves into the sea and is coagulated by the salt water as succinum, commonly called amber. The floating oil has been noticed from time to time and has been reported in the newspapers occasionally, but in later years records have been kept carefully so that it is possible to locate the origin of the field and to determine its extent.

The Deposits.—The mud lumps which appear only outside the passes of the Mississippi in the borders of the Delta are upheavals resulting from gases caused by the decomposition of masses of vegetable matter which have floated down the river and been buried in the silt. The combination of these sediments of vegetable matter, the salt water, the exclusion of the air, and the impervious cover of the silt offer ideal conditions for the production of bitumens; this is generally a long process, but the earliest stage of the process is found in these mud lumps in full force. The formation of hydrocarbons is promoted by the action of the sodium chloride on the decaying vegetable matter and is helped by the presence of the fishes, diatoms, algæ, and other minute organisms of the ooze, which all furnish material for the change. A destructive distillation is set up by which the substances heated without access of free oxygen undergo complex decomposition by which volatile products escape and a residue of carbon is left. Under the very moderate temperature the principal product of the mud lumps is methane or marsh gas. The pressure of the gas, and perhaps the weight of the jetties, finally forces upward the overlying mud in a dome shape, which has been known to cover as much as 30 acres. Where they rise above the water the lumps generally show a small crater from which the semiliquid mud is extruded. By driving a pipe down through the lump a gas escapes which is easily lighted.

Near the shore at Sabine Pass west of the west jetty there is a deposit of a viscid tarry liquid of bituminous odor which impregnates the mud, and when the mud is stirred by wave action or mechanically the globules of oil rise to the surface and spread out so that in storms there is no break, and the location has become celebrated as an oil pond. The appearance is irregular and the origin is uncertain; the oil probably occurs in a porous bed under the water whose cover is sufficiently pervious to permit a constant though very slow seepage sufficient to allow the overlying mud to become saturated. The oil contains carbon, hydrogen, nitrogen and a trace of sulfur.

A peculiar substance called sea wax is frequently found on the beaches between Sabine Pass and Matagorda. This is found in large cakes as large as 6 or 8 feet long and 1 or 2 inches thick. It is undoubtedly a petroleum or asphaltum residuum and its presence points to the existence of springs of liquid bitumen somewhere in the Gulf.

The chart shows a number of oil spots south of Trinity Shoal from Ship Shoal to Sabine Bank, but these have only been reported in later years and are undoubtedly the refuse from the oil ships and barges when they clean tanks before going into Sabine Pass.

Along the Mexican coast and near Campeche Bank floating oil is reported occasionally, but the first record appears in 1907 and it may come from either of two sources: from the northern field drifting before a gale or the overflow from the Mexican oil fields.

During the last seven years the reports from vessels that have passed through the oil field in the Gulf have been frequent, principally because attention has been especially directed to it; the positions where it has been reported are plotted on the chart so that its limits have been determined with considerable accuracy, and the point of origin has been located almost exactly as being at latitude 27 deg 30 min N and longitude 91 deg 30 min W. A number of vessels have reported from this position that the oil was seen bubbling on the surface, while the report on September 10th from the steamship "Comedian," described it particularly as coming up in three jets. It is generally described as dark or dark yellow [illegible] so thick that a vessel passing through will hardly make a ripple on the water. The oil floats away from the source in long fields, but it absorbs oxygen from the air and evaporates quickly. On evaporating the oily residue of hydrocarbons disappears and the emulsion mixing with the water first has the appearance of slime which is generally reported as discolored water, and later it turns the water milky white, which appearance is often reported in the eastern part of the Gulf current and as far south as the Florida Reefs.

The Source.—The location at 27 deg 30 min N, 91 deg 30 min W is nearly south of the Trinity Shoal, from which it is distant about 120 miles, and the chart shows depth of 600 fathoms. The Continental Shelf with a general southeastward dip is 90 miles in width from the Coastal Plain to the edge of the Shelf at a depth of 100 fathoms (600 feet), in 25 miles from the edge the bottom drops off to 600 fathoms (3,600 feet) and in 20 miles more to 1,000 fathoms (6,000 feet). The source may be at any one of these depths between 100 fathoms and 1,000 fathoms. Careful soundings would probably show in this vicinity the presence of one of the dome-shaped uplifts which are a peculiar topographical feature of the Coastal Plain of this region. The outlet of this ascending column of oil is probably located at some point of structural weakness or fissure from which the oil impregnated with sulfur floats upward, sometimes slowly and sometimes impelled by a tremendous force.

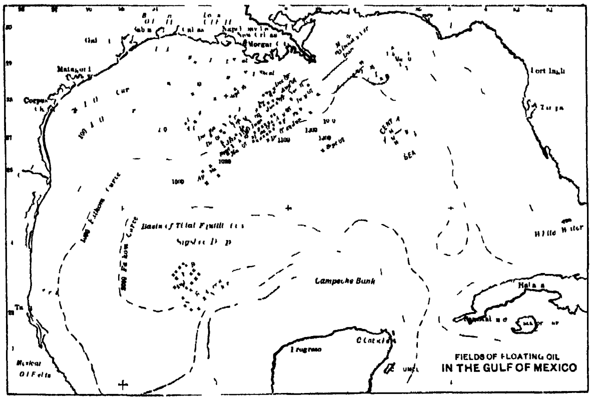
Movements of the Earth's Surface.—The crust of the earth, seemingly solid, slowly rises and falls, now revealing the bottom of a shallow ocean border as a land surface and again submerging a low continental border beneath the sea. Such movements have repeatedly taken place and they are still in slow progress, especially during the Tertiary Age the boundaries of the land and sea appear to have been in a state of frequent oscillation, judging from the proofs which the strata afford of the return of the ocean more than once to the spots from which it has retired. The deposits of ooze belonging to different periods or depths found on high land indicate that the movements of upheaval and subsidence have been going on continually though the movement is slow. These changes are ordinary and not extraordinary events; movements of elevation are as common as movements of depression but upheaval has been more rapid than erosion and more general than subsidence over the Coastal Plain and the Continental Shelf.

There appear to have been frequent oscillations throughout this territory, the land first sinking to the east and rising to the west, then the land in eastern Texas and southwestern Louisiana began to sink and continued to do so until a depth of 500 feet was reached at the close of the Eocene. After this there was a gradual elevation increasing steadily until the present shore line of Texas areas had an elevation of 400 feet. Following this high continental condition there was another depression when the sea again encroached on the land, the present shore line sinking to a depth of 100 feet below sea level. This sinking appears to have been accompanied by a tilting of the land and it was probably during this period that a considerable part of the flexing or faulting of the beds took place, resulting in the line of dome-shaped elevations which occur in the southern part of Louisiana. Again the sea receded and high level conditions prevailed, but the flexing or faulting of the preceding periods continued through this one; the domes were raised higher and their crests formed reefs and islands. The land subsequently tilted seaward and enormous vegetable deposits were brought down by the floods. A further slight rise took place and the shore line moved southward about where the Trinity Shoal is now. The final change followed this elevation and present conditions were inaugurated; the sea began to encroach slowly on the land east of Trinity Shoal, though to the westward the land is slowly rising.

These changes, which have been going on for centuries, have resulted in the formation of lines of structural weakness in the underlying formations, though many of the fissures have probably been sealed by the deposition of overlying strata of sand and clay.

In the early formations the sand [illegible] to be the heaviest deposits on the shelf and the well records show the same conditions down to [illegible] feet with deposits of sandstones and limestones to a depth of 1,000 feet.

The porous beds underlying the Coastal Plain are thoroughly saturated and in many places oil pools have formed. The location of the oil pools is deter-



FIELDS OF FLOATING OIL IN THE GULF OF MEXICO.

mined by certain structural features and particularly by the domes, while dislocations of the strata in the form of faults or flexures suggest the points where deposits of oil will occur. All the flexures on the land follow the northeast southwest lines, and the axes of the dome-shaped uplifts on the land fall naturally into the same linear arrangement while the slope of the great submarine flexure between 100 fathoms and 1 000 fathoms extending from Tampico to Mobile follows the same general direction and nearly coincides with the line of weakness on the Coastal Plain of the Atlantic

Genesis It hardly comes within the scope of this paper to discuss the genesis of the petroleum, but the differences in the deposits at different points are so striking that they call for some notice, while the study of any subject which is based largely on hypothetical reasoning, is always enriched by suggestions which may or may not lead in a useful direction

In the borders of the Gulf are the great oil fields of Mexico, Texas, and Louisiana, the salt and sulfur deposits of Louisiana, the coal and iron deposits of Alabama, and the phosphate beds of Florida On the shores of the Gulf are deposited surface oils in different forms, and in the deep water there is a source of petroleum There is a constant progression of an enormous body of warm water from the tropics which makes the circuit of the basin, following the contour of the Continental Shelf and carries on its surface great floating fields of algæ There is a great deep of 2,500 fathoms in the middle of the Gulf in which the water is colder and denser than elsewhere The Mexican volcanoes extend over a fissure across the Mexican Plateau from Colima to Tampico, and the main line of structural weakness continues across the Gulf toward the Louisiana coast and extends northward through the igneous rocks of the Appalachian range to the basic lavas of the Palisades, and thence along the coast to Iceland

The oils which are found on the borders of the Gulf and those which appear floating on the deep sea are so different in their characteristics that they seem to have been separated by nature into two classes, one having an organic and the other an inorganic origin.

The bituminous deposits along the shores, the methane of the mud lumps, the sea wax, the oil ponds, are probably all due to organic agencies The vegetable and animal remains which have given rise to local deposits, the presence of the fucoids and diatoms in enormous quantities which slowly decompose and sink into the oozes, the climatic conditions, and the temperature of the water, all contribute material for the change into hydrocarbons But the oils in these deposits contain no soluble salts and no free sulfur. In some cases plants predominate in the formations, in others animal remains, and the resulting products vary as petroleum varies in different fields.

The floating oil in the deep water is probably of azoic origin As it reaches the surface and absorbs the oxygen it evaporates quickly, and, when seen, it appears to be an alteration product which has many of the characteristics of petroleum spirit, containing sulfur compounds It loses its fluorescence rapidly and degenerates into slime and then to milky water Near the source, however, it is heavy dark yellow and with a strong petroleum odor.

As the flow of oil at or near the same spot has been more or less continuous ever since the days of which we have any record, it is probable that there is an enormous oil pool underneath the Coastal Plain and the Continental Shelf of Louisiana and Texas, which lies at a depth of more than 2,000 feet. At the time of the last subsidence of the crust the impervious cover of the pool was probably borne down by the great weight of the superposed deposits until the cap rock was broken, allowing the continuous escape of some oil which had accumulated below that stratum. Under any circumstances it would be easy and natural for the oil to pass up through the water to the surface and be dissipated, but when we find the oil rising through a great depth of water with such violence as to displace the water in jets, it is evident that the pressure of gas behind the porous rocks is enormous.

The oil deposits of Louisiana which are known to be under the Coastal Plain, and those which are apparently under the extension of the Coastal Plain into the Continental Shelf, either immediately preceded or immediately followed the salt and sulfur solutions; they are all sulfur oils and, below the oil horizons, the sand is generally filled with salt water. Sulfur deposits are due to the action of volcanic gases; hydrocarbons are derived largely from the igneous rocks. chemical reactions in volcanoes need the co-operation of water and, in fact, steam, charged with carbon dioxid and sodium chlorid, is the mainspring of all volcanic phenomena, the gases of an expiring volcano consist of vapor, sulfurous acid and sulfureted hydrogen, hydrochloric acid and chlorid of ammonium. All these conditions are favorable to the deposits of the hydrocarbons which, associated as they are with volcanic and intrusive phenomena, are believed to be due to inorganic agencies

The organic oils on epigene waters or springs, rise to the surface by capillary action and buoyancy in a steady flow due to hydrostatic pressure, but the inorganic oils from hypogene sources are forced through the openings under tremendous pressure by the intermittent power of the gas

CURIOUS IMPORTATIONS.

SOME STRANGE ARTICLES ENTERING THE FOREIGN COMMERCE OF THE UNITED STATES.

Recent tariff discussions which include the rates of duty on articles almost unknown by name to the general public have illustrated the breadth of scope of the commerce of the United States The fact that the world is ransacked for articles to contribute to the wants of the American public and that the American producers and manufacturers in turn supply to all parts of the world articles which are in many instances not considered by the general public as entering international trade, is sharply pointed out by these discussions and the great inquiries which grow out of them

The great variety of the articles forming the trade of the United States with other countries is illustrated more clearly by the Bureau of Statistics' figures of imports than those of exports, due to the fact that its import record is necessarily stated in terms of the tariff law The fact that the tariff places rates of duty upon different articles, and that the Bureau of Statistics must state the quantity if possible and the value in all cases of each of the articles or class of articles upon which a separate rate of duty is named requires that bureau to differentiate much more closely in its statement of imports than that of exports As a result its statement of articles and grades of articles imported contains many thousand items

A study of this statement "Imports for consumption" as issued by the Bureau of Statistics and constantly consulted by statesmen in preparing and discussing and acting upon the tariff shows many curious facts regarding articles included in the import trade of the United States

Wild animals for example, imported for zoological exhibitions and scientific and educational purposes, which are permitted to enter free of duty because of their prospective use for educational and scientific purposes amounted in 1908 to between six and seven thousand dollars while those imported for other purposes evidently exceeded this sum by far, since the group "All other animals," aside from cattle, horses, mules, sheep swine animals for breeding purposes, and teams of immigrants still shows a value of over one hundred thousand dollars

Birds imported in 1908 amounted to over three hundred thousand dollars in value and while they are not specifically enumerated as to varieties, it is presumed that this group is largely composed of canaries and parrots

Leeches are also enumerated by the Bureau of Statistics under its general head of animals imported, the total value of the imports of this species in 1908 having been $5 341, in 1907 $6 992, in 1906 $4,494, in 1905 $3 862, in 1904 $3 589 in 1903 $3 240, and in 1902 $2 412 the commerce in leeches being thus of a growing character The total value of the leeches imported into the United States in the decade ending with 1908 is about $40,000 Leeches, it may be added, are imported free of duty Snails were at one time enumerated as an article of importation the records from 1894 to 1898 showing snails imported to the extent of about $5,000, but the snail trade so dwindled, showing only $24 of imports in 1898 that the bureau discontinued its statements of this article

"Divi divi" as an article of importation has been the subject of many jests by the humorists during the tariff discussions of Congress, though in fact it is an article of no inconsiderable importance in the tanning industry, the product of a leguminous tree in the West Indies and South America, entering in the form of a pod, and amounting in quantity in 1908 to one hundred and thirty four thousand pounds valued at between two and three thousand dollars The value of the imports of the last decade has aggregated about $85 000 Divi-divi, which does not compete with other grades of material used in tanning, and which is required in the development of certain lines of this industry, is imported free of duty

Rose leaves are also imported free of duty when brought in in a crude state, the value of the imports of 1908 being but $105, in 1907 $2 137, and in 1906 $5 879, the value of rose leaves imported in the decade ending with 1908 amounting to over $20,000

The extension of the chewing gum industry and the use of that product among the people of the United States is illustrated by the fact that the importation of "chicle" in 1908, chiefly for use in the manufacture of chewing gum, amounted to more than four million pounds. This article, "chicle," is obtained in southern Mexico from the trunks of the sapodilla plum tree, and the importation of this gum during the last decade has amounted to about thirty million pounds, or about fifteen thousand tons, valued at over eight million dollars

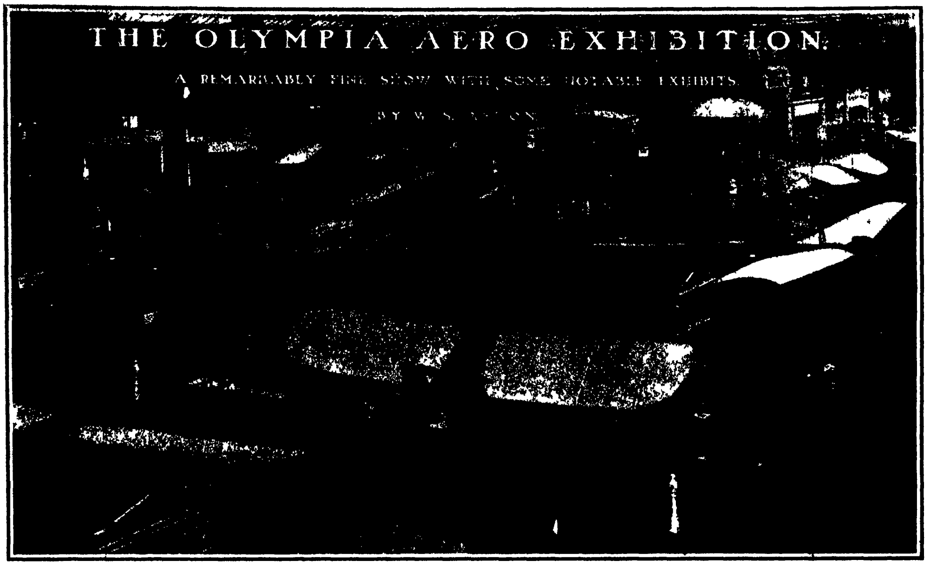
"Dragon's blood" imported, amounting on the face of the returns to fifteen thousand pounds in 1908 and to over two hundred thousand pounds in the last decade, is of course not in fact dragon's blood at all, but a mere name for a deep reddish resinous substance obtained from a variety of trees in the Orient, especially the east coast of Sumatra, and used as an ingredient in varnishes, stains, and dentifrices The value of the importation of 1908 was about five thousand dollars and during the decade about sixty thousand dollars

Infants' foods also form a considerable item of importation, forty-one thousand dollars' worth in 1908, and during the decade have amounted to nearly a quarter of a million dollars, on which the duty collected amounted to nearly fifty thousand dollars.

"Nux vomica" forms a more important feature of the import trade than would probably be realized by the average individual unacquainted with this particular trade The Bureau of Statistics' figures show that the importation of nux vomica amounted, in round numbers, in 1908 to three million pounds, valued at fifty four thousand dollars, while the quantity imported in the decade ending with 1908 amounted to about twenty five million pounds, valued at over four hundred thousand dollars This article comes in the form of large round seeds of a tree grown chiefly in southern Asia, and is used in the manufacture of strychnine and certain tinctures and tonics prescribed as medicines, and since it does not compete with any product of the United States, enters free of duty

"Palladium" is also an article of commerce, though in extremely small quantities, since the quantity of palladium imported in 1908 was but three one hundredths of one pound This small quantity, three one-hundredths of one pound, was, however, valued at $21, a pound therefore being worth $700. In other years the quantities imported have been much larger, amounting in 1905 to over ten thousand dollars in value, and in 1904 to more than sixteen thousand dollars in value This rare metal, associated with platinum, while found in its native state in small quantities in Germany and Brazil, is chiefly supplied from the working over of platiniferous residues of various mints, and is used in the manufacture of astronomical instruments, and by dentists, when alloyed with silver, as a substitute for gold—The Railway Conductor.

The Panama Canal excavation during April amounted to 3,454,649 cubic yards, place measurement, against 4,062,632 cubic yards during March, the latter record probably being as high as will be attained in the future, unless some reason should arise for pushing the work at a faster rate than has hitherto been considered desirable. The falling off last month was the inevitable consequence of the beginning of the wet season. In the rainless months work progresses under conditions that are impossible during the rains The necessity for ballasting the tracks of the construction lines does not then exist, and it is not until the beginning of the wet period that track work becomes a serious problem. Moreover, the difficulties of keeping the dumps in shape and other working conditions favorable for a high rate of progress are considerably greater after the middle of April The decrease in excavation by steam shovels was from 2,535,198 cubic yards in March to 2,137,864 in April; and by dredging from 1,527,434 to 1,316,788. The total amount of excavation since the United States took charge of the work has been 73,000,000 cubic yards, leaving about 101,500,000 cubic yards to be taken out in order to complete the 85-foot level canal. An examination of the figures will show that even at the low average rate of 3,000,000 cubic yards per month the excavation can be finished in about two and a half years.



THE OLYMPIA AERO EXHIBITION.

A REMARKABLY FINE SHOW WITH SOME NOTABLE EXHIBITS.

BY W. S. [illegible]

The Olympia Aero and Motor Boat Exhibition opened on March 11th and closed on March 18th, and as regards its first and most important motive it can be written down without doubt as the greatest aeronautical show ever held in the eastern hemisphere. The Paris Salon held in September last had the advantage of greater space and surroundings more closely approaching the ideal, but as regards originality, sound design, and constructive workmanship, and also as regards the number of exhibits, it cannot compare with the Olympia show. It has been suggested, and no doubt there is a certain amount of truth in the contention, that the English have not yet learned to take aviation seriously, but the present exhibition will go far to refute that criticism, well merited though it was. The British firms that have taken the matter in hand have left no stone unturned to get well to the forefront of the coming industry, and though the number of British machines which have successfully flown is at present a rather small one, yet it is safe to say after a closely critical inspection of the aeroplanes on exhibition that the very great majority, in fact practically all of the machines shown at Olympia will fly. While a number of the machines are certainly original, they earn the epithet rather for originality in detail than in broad design. Their manufacturers have been wise in turning out something which has a precedent for claiming to fly rather than developing ideas which are not likely to be convincing.

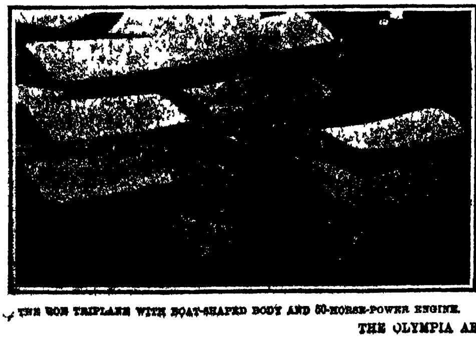
The show embraces some 40-odd complete machines, of which at least 25 can be relied upon to fly, 12 at least having done so already. Besides a very interesting and instructive model section and several balloons, there is also shown the Willows 40-50 horse-power dirigible which has already performed in a highly successful manner.

Perhaps the most interesting machine in the show is the Le Blon Delagrange type of Humber monoplane, of which a photograph is reproduced. In plan and general arrangement it resembles a Blériot XI, but differs chiefly in the body, which consists of a long tapered tube built up of thin wood strengthened with a spiral canvas wrapping. Great strength is thus obtained with extreme lightness. A special feature has been made of the elimination of wires with the excessive resistance they occasion when in a state of vibration. The wings are trussed with flat steel ribbons, and instead of being warped for lateral stability, their rear edges are flexible their entire length, so that the aviator can flex them up or down. This amounts to a variable camber or curve flattening device, which should make the monoplane very speedy. The flexible rear edges are as in the Blériot machine interconnected with the rear vertical rudder. They can be worked together also so that a greater curve and increased lift can be obtained for starting purposes. The usual running chassis is used, and the propeller is a single 2-bladed one driven by a 3-cylinder air-cooled Humber engine very similar to the Anzani. The gasoline and oil tanks and the control wires are all hidden in the tubular body, on which the aviator sits with one leg on each side. The spread of this monoplane is 29 feet, its surface 1[illegible]2 square feet, and its length 26 feet.

A Humber monoplane, Lovelace type, a close copy of the Blériot XI, is shown together with a Humber Lovelace biplane, which is practically a Blériot monoplane with a superposed main plane. It carries three passengers and is driven by a single traction screw on the shaft of a [illegible]0-horse-power 4-cylinder water-cooled engine.

The Gr[illegible] & Jobling biplane has fore and aft control on the lines of the Curtiss, but is full of original points. The control arrangement takes the form of a vertical steering wheel mounted on a pivoted vertical pillar. Moving the wheel bodily toward or from the aviator operates the front horizontal rudder (the tail is fixed); moving it bodily from side to side actuates the side ailerons, and rotating it on its axis turns the rear rudder. It has a single propeller driven by a 50-horse-power Green water-cooled engine. The spread and length are both [illegible]0 feet, while the supporting surface is 3[illegible]0 square feet.

The Wright machine made under license by Messrs. Short Bros., upon which the Hon. C. S. Rolls has performed so successfully, winning several prizes, is shown together with a new Short machine on modified Wright lines. It has a large cruciform tail, the horizontal part of which is movable in conjunction with the front horizontal rudder. A single propeller with a diameter of 7 feet 6 inches, and a pitch of 4 feet 10 inches is used, and is driven by a [illegible]0-horse-power Green engine placed behind and on a level with the head of the aviator, so that the body resistance is reduced to a minimum. The landing chassis is arranged in a rather original manner, and embraces running wheels as well as landing skids. When required, for instance in landing, the wheels are drawn up about the skids by a ratchet contrivance, and in this way the shock is transmitted over a large surface. The balancing planes between the main planes have a rigid front half, but the trailing edge is attached to a light spar by spiral springs



THE ROE TRIPLANE WITH BOAT-SHAPED BODY AND 60-HORSE-POWER ENGINE.

THE HON. C. S. ROLLS'S WRIGHT MACHINE BUILT IN ENGLAND.

THE OLYMPIA AERO EXHIBITION.

which render it very flexible. This device has been found of great value on the modified Wright triplane which Short Bros built for Mr Moore Brabazon on which he won the Daily Mail £1 000 prize for the first Englishman to fly a mile on an English machine. This machine is also shown and is principally notable for the unusual paper dart tail with which it is provided and which is shown on our front page.

THE MULLINER MONOPLANE WITH 8-CYLINDER AIR COOLED MOTOR.

Among those Englishmen who have already flown A V Roe has been the most persistent trier and has done some really marvelous performances on a somewhat carelessly built triplane the power plant of which was a 9 horse power motorcycle engine. He now shows a beautifully made model on improved lines of which a photograph is reproduced. During the show he made some capital flights with it at Brooklands. Although the dimensions are the same as those of the original aeroplane or avroplane as he calls it viz 40 feet of entering edge giving a total lifting surface of 310 square feet he now uses a 50 horse power four cylinder water-cooled Green engine. The fore half of this machine is built on the lines of a yacht's hull with thin wooden planking and the total weight in flying order is only 4 0 pounds.

There are of course a number of machines closely resembling the Blériot No XI monoplane the cross channel type. Among them is the Lascelles with a four-cylinder air-cooled engine with cylinders arranged semi radially the Lane the Holland & Holland the Howard Wright. Besides these there are two examples of the genuine Blériot shown by Louis Blériot himself and Blériot Ltd the English agents. Many of the above machines while being admittedly imitations have a number of original details which are generally speaking improvements.

A highly interesting production is the Petre monoplane which while resembling a Blériot in plan has a single propeller behind its tail the screw being driven by a long light hollow shaft carried in a series of ball bearings. The framework is shaped like an inverted canoe and the aviator sits in the immediate bows where he controls the machine either by increasing or decreasing the angle of incidence of the main plane or altering the tail or operating ailerons which form the corners of the wings of the main plane.

Although the actual machine is not shown in the exhibition the A S L monoplane is particularly interesting because it is what may be described as a Wright monoplane i e it flies with its tail first. This monoplane flew highly successfully at its first attempt a week before the show opened and has since performed extremely well.

The Mulliner monoplane is one of the finest pieces of workmanship in the show. The main stringers forming the longitudinal members of the fore body are channeled and drilled like the frame girders of a racing car and are extremely strong and light. The wood used is English ash seasoned by ten years storage. This monoplane is 26 feet long by 33 feet spread and has a lifting surface of 220 square feet. Its weight in flying order is but 380 pounds. It is driven by an eight cylinder air-cooled J A P motor weighing 270 pounds.

The Star monoplane in general appearance resembles the Antoinette but it has a peculiar form of tail which is depended upon for the complete lateral and longitudinal control of the machine. This tail is composed of four planes forming two horizontal and two vertical rudders which when all turned in the same direction form as it were a windmill with very slow pitch blades which has the effect of turning the machine about its longitudinal axis when required by circumstances. At the same time the planes forming the vertical rudder can be worked independently of the horizontal tail as also can those forming the vertical rudder. Whether a recuperative moment can be obtained satisfactorily with the tail in this manner remains to be seen but a similar machine built with a much smaller engine the present monoplane has a 25-30 four cylinder engine—has made several promising short flights.

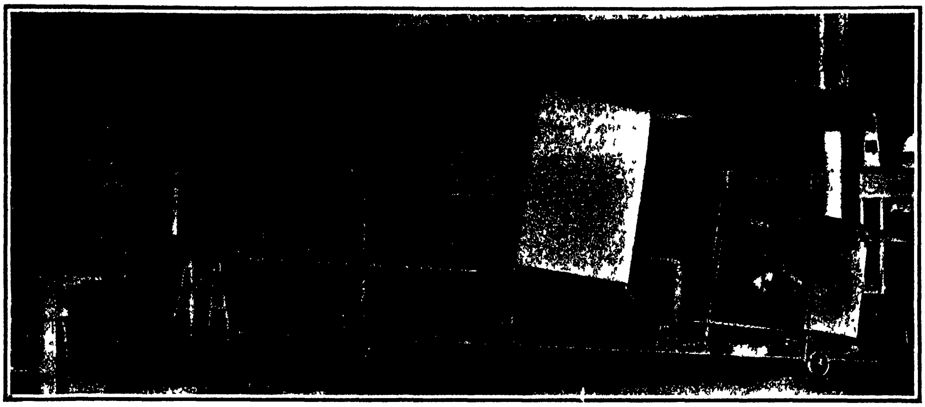
The Clement Talbot Co show a fine example of the Santos Dumont Demoiselle with detachable wings made of the finest grade of silk and constructed with irreproachable workmanship. The spread of the main planes is 17 feet and the depth 7 feet. The engine is a new Clement Bayard model giving 30 horse power and having horizontally opposed cylinders with electrically deposited copper water jackets. The body of this machine is entirely of elliptical section steel tube of great strength and lightness Santos Dumont's original bamboo frame having been entirely discarded. The control arrangements are of the simplest possible form the ignition being operated by a string hanging down in front of the driver's face

THE LASCELLES MONOPLANE DRIVEN BY A 4-CYLINDER AIR-COOLED SEMI RADIAL MOTOR.

THE OLYMPIA AERO EXHIBITION.

the throttle by a similar string running down and attached to a foot lever while the tail wing warping and vertical rudder are operated by a lever at each side of the pilot and a drum wheel on his left side

The English Darracq Company having obtained the rights of the Farman Company in England shows a Henry Farman biplane with a 40 horse power double opposed four-cylinder engine



THE ZODIAC BIPLANE ONE OF THE LATEST FRENCH TWO SURFACE MACHINES WITH SEVERAL NOVEL FEATURES

A new biplane on somewhat similar lines to the Farman is the Zodiac made by the well known French balloon constructors This machine has a monoplane tail instead of the usual box construction and has vertical panels between the planes like the Voisin but these panels are between the ends of the planes only A single propeller driven by a 50 horse power four cylinder Green engine is used

Among the engines shown on various stands are several interesting types in addition to those already touched upon The Isaacson motor is of the rotary or Gnome type and has its six cylinders arranged radially around a single crank throw The cylinders are water cooled their jackets all being connected up in series by a number of circumferential water pipes forming a rotary radiator and as the jackets are of ample capacity no water tank is required All the valves are in the cylinder heads where they are worked by a common stationary cam and the gas is admitted to the cylinders through a star pipe centered on the hollow crankshaft

The N E C engine is of the two-cycle type and is shown fitted to several machines Already some good flights have been made with this motor which has some unusual features It works on the scavenging principle a couple of rotary blowers feeding the cylinders with gas and air respectively being attached to each cylinder and the admission being by rotary piston valves

The Lamplough turbomotor is a highly original form of engine which has given good results on the bench although as yet untried in the air A plate is obliquely and loosely attached to the stationary crank shaft and to this plate are secured by means of knuckle joints the connecting rods of the two double pistoned two cycle cylinders As the plate revolves its altering angularity causes the piston to reciprocate mixture being fed in by direct plunger pumps with pistons articulated to the driving plate The two working cylinders are air cooled and a single explosion in each takes place between the two pistons which work in opposite directions

There are of course a number of other features of interest in the Olympia Aero Show which it may be noted has been patronized and visited by His Royal Highness the Prince of Wales but a description of them would require more space than we have at our disposal

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A paper by Dr F Mollwo Perkin and Mr W E Hughes entitled Studies on the Electro-Deposition of Metals was read in abstract by Dr Perkin before the Faraday Society on January 18th The authors describe a rotating cathode employed for rapid electro deposition of metals It consists of sheet platinum spun up so as to form a narrow thimble the upper end being open and having a stout iridium wire fused to it This electrode which has an active surface of 1 [illegible] centimeters is rapidly rotated within a cylindrical platinum gauze anode In other cases particularly when graded potential methods are employed a spiral anode of platinum is rotated within the gauze cylinder which then functions as cathode In the potential measurements a cylindrical glass funnel with a glass tube sealed in the side is employed for holding the electrode

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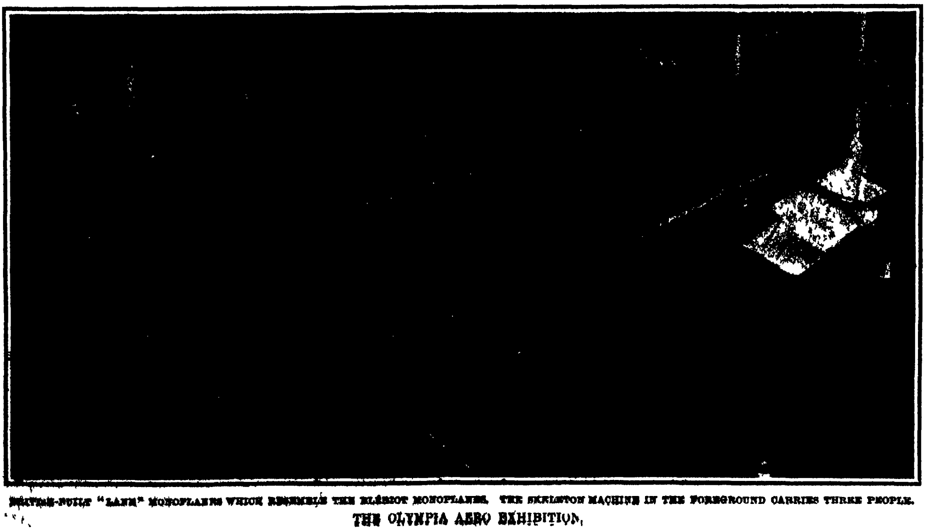
Fluid Bronze (according to J L Stromhein) —Gum dammar is melted with an addition of about 1-3 anhydrous carbonate of potash or soda and kept for three days stirring occasionally in this condition Then the alkaline resinous mass is to be finely pulverized spread on trays in thin layer exposed to a temperature of about 106 deg F and left thus for several months The resin thus obtained is dissolved in benzine or some other petroleum distillate with a low boiling point after dry ammonia gas has previously been for a long time passed through the solvent In the varnish thus obtained the fine powder, bronze is stirred it remains suspended therein and is then ready for use



BRITISH-BUILT "LANE" MONOPLANES WHICH RESEMBLE THE BLÉRIOT MONOPLANES. THE SKELETON MACHINE IN THE FOREGROUND CARRIES THREE PEOPLE.

THE OLYMPIA AERO EXHIBITION.

THE SOUTH POLE.

THE COMING ANTARCTIC EXPEDITIONS.

The years 1910 and 1911 promise to be particularly noteworthy in the annals of Antarctic exploration. On February 1st Commander Peary proposed to the Board of Managers of the National Geographic Society that the Society and the Peary Arctic Club should together send out an expedition to the south polar regions to explore the coast of Weddell Sea and if possible reach the South Pole *via* this route. The proposed expedition would leave the United States in August of this year and cross the Antarctic Circle about January 1st, 1911. Commander Peary offered on behalf of the Peary Arctic Club to place the steamship "Roosevelt," which it will be remembered, was built by the club especially for polar work, at the disposal of the expedition provided the Society would assume the initial expense of $[illegible]0,000. He also proposed that expenses above $[illegible]0,000 be divided equally between the Peary Arctic Club and the National Geographic Society. He estimates the total expense of fitting out and maintaining an expedition in the south polar regions for one year at between $[illegible],000 and $100,000. All of Commander Peary's recent polar equipment including sledges, fur clothing, and camp equipment would be placed at the disposal of the party.

[illegible] the world has ever seen, to the words of Commander Peary, fresh [illegible] Capt. Scott sailed last August, and after wintering in McMurdo Sound [illegible] which he hopes to reach by the end of December. The American [illegible] its utmost the same month. The interest in the latest South Polar [illegible] by the sporting character it now assumes.

THE QUEST OF THE SOUTH POLE.

A British expedition under Captain Scott will leave in August, 1910, and spend the year 1911 in Victoria Land for the purpose of reaching the South Pole. The American party will start exactly opposite the English base.

The United States navy, it is said, may send an expedition to relocate Wilkes Land in the south polar region, a country discovered by an American naval officer, and to take possession of it in the name of the United States.

It has generally been accepted by foreign authorities that d'Urville sighted the land of the Antarctic Continent which he named Adelie Land on the same day (January 19th) that Wilkes discovered land 100 miles to the eastward which he named Cape Hudson, and also that D'Urville's Cote Clarie, in longitude 1[illegible]1 degrees east, was sighted by him the day before it was seen by Lieutenant Ringgold on board U. S. S. "Porpoise." According to Rear Admiral John E. Pillsbury, U. S. N., in a recent number of the National Geographic Magazine, investigations show that both of these assumptions are in error, and that in fact d'Urville first sighted Adelie Land the day after Wilkes sighted Cape Hudson, and that he sighted Cote Clarie the same day that it was sighted by Ringgold, but at a later hour. Wilkes cruised along the coast of this continent for more than 1,600 miles from his first landfall. Future exploration may and indeed probably will find that much of the land discovered by him was placed too near the barrier, or in other words too far north, for it is well known that distance estimated by the eye is liable to great error, and particularly is this the case in the polar regions.

Wilkes called this land the Antarctic Continent. It must belong to the entire continent the existence of which he revealed. Some geographers have recognized that the part of Antarctica which he discovered needed a special name and, therefore, gave it the names of Wilkes Land. When it is remembered that Wilkes changed the conception that the Antarctic was an ocean by demonstrating that it is a continent, the least that his discoveries demand is that the name of Wilkes Land be retained on all of Antarctica lying between the longitudes of 95 degrees and 158 degrees east.

The American Museum of Natural History will send an expedition to the South Pole to study extraordinary forms of animal and vegetable life existing there. The expedition will be named in honor of Morris K. Jesup, the late president of the museum.

Lieutenant Shackleton's expedition will probably attract most attention, largely because Shackleton holds the South Polar record. In all likelihood he will go efficiently equipped this time.

Among the more or less fanciful schemes of reaching the South Pole may be mentioned Captain [illegible] V. Webster's illusory idea of reaching the pole by a combined aeroplane and balloon, following the route of Lieutenant Shackleton overland as far as possible at first and making the final dash in his airship.

It is said that two Russians, Baron Mathiessen and Baron Voltchoeck, will make the attempt with two dirigible balloons. After Wellman's fiasco it seems hardly likely that any such scheme can succeed.

How much truth there may be in the rumor that the Germans will take part in the race for the South Pole it is difficult indeed to judge.

No region in the world presents such problems for exploration and the advancement of science as are to be found around the South Pole. Here is a continent greater than the United States and Alaska combined, much larger than Europe, a continent which has been penetrated in only one direction, namely by Scott and Shackleton from Victoria Land. Even its coast lines are little known. It is believed that the greater part of this continent ranges in altitude from 8,000 to 14,000 feet above the sea, making it probably the largest continental mass above sea level in the world.

Planted on the fringe of this vast continent of snow and ice are lofty volcanoes like Terror and Erebus, which are belching continually smoke and fire. Here lives the most remarkable bird known to science, the penguin, which lays its egg on a cake of ice in the blackness of a polar night, when the temperature is not less than [illegible]0 deg. below zero, and then holds the egg and then the chick on its feet until the young bird can take care of itself.

Dense pack ice surrounds the Antarctic area and makes the approach to land difficult from all directions. But the great engines and heavy frame of the "Roosevelt," which is more powerful than any vessel hitherto employed in South Polar work, should enable her to pound a path where previous ships have been helpless, and thus to carry the American party to an advantageous base. Exactly where this base shall be cannot be determined until the party get in the ice and find where they can go, but Commander Peary proposes that the American expedition should make its headquarters somewhere on the coast of Weddell Sea, probably in the vicinity of Coats Land, which was discovered by Captain Bruce of the Scottish expedition in 1904. It is hoped that a base can be found here less than 900 miles from the pole.

This particular section is the least known in the Antarctic area. Bruce succeeded in getting within a few miles of the coast, but he did not land. Ahead of him were ice-clad slopes which he believes ascend to a plateau which may be an extension of Victoria Land. All explorations in this region would be absolutely new discoveries and would benefit geology, zoology and all kindred sciences.

The chief difficulty to be encountered from the New Zealand side will be the Great Ice Barrier, discovered by James Ross in 1840, rising from the sea to an average height of nearly 200 feet and stretching from King Edward VII Land to South Victoria Land, a distance of about 400 nautical miles. Little is known about this great barrier.

According to Henry Gannett in the National Geographic Magazine it was not until Scott in 1902 and Shackleton in 1907 made their remarkable sledge journeys in the interior of Antarctica that the nature of the great ice barrier became known.

The barrier is simply the southern limit of a great sheet of ice extending southward up a great bay which penetrates the land at least 300 miles and possibly double that distance. Indeed it is possible that it may extend entirely across, joining with Weddell Sea on the opposite side and dividing Antarctica into two continents. From the barrier southward this bay, with a known area of at least 100,000 square miles, is entirely occupied by this ice sheet. It is bordered on the west by high mountains, from which stretches westward a still higher plateau, which reaches an altitude of over 11,000 feet at Shackleton's farthest southern point. The land on the east side of the bay is unknown, except at the point of King Edward VII Land, where the barrier joins it, but it also is probably mountainous.

From the high land on the west side numerous glaciers descend to this field of ice. Notable among them is that by which Shackleton ascended to the summit of the plateau in his wonderful sledge journey toward the South Pole, a glacier 100 miles long and 50 miles wide, with a descent of 8,000 feet. From the east side of the bay, and especially from its south end, probably other great glaciers contribute to the great ice field.

The name "Great Ice Barrier," originally applied only to the ice cliff forming its northern limit, has been extended and applied to the ice field itself and even to the bay which it covers. It is unnecessary to say that these extensions in the application of the name are inappropriate, and it is to be hoped that suitable names will be selected for these features. I would suggest for the ice field the name of Shackleton glacier, since Shackleton has made the most extensive explorations of it and its surroundings; moreover, I hope to show that it is in truth a glacier, although both Scott and Shackleton refuse to accept that explanation of the phenomenon. It is their belief that it has been formed from snow falling upon its surface, much as the sea ice of the Arctic is formed. But sea ice nowhere accumulates to any such thickness as this or presents an ice wall at its borders. On the other hand, every glacier that reaches the sea presents just such an ice wall. There are scores of such glaciers on the Alaskan coast and probably hundreds on Greenland, Grant Land, and Spitzbergen, whose fronts extend out into the sea, even into water so deep that they must be afloat, as is much of the barrier.

The snow which falls upon the surface of this ice field could not possibly supply the waste from the barrier, and another source of supply must be found. This supply is in the numerous and large stream glaciers which bring down the ice from the highlands on the east, west, and south of the bay. The area thus drained must be enormous, amply sufficient to maintain the supply.

The fact that this great ice field is moving northward at the rate of about one third of a mile a year, as ascertained by Shackleton, would seem in itself as a conclusive demonstration that it is a glacier. Sea ice, unless driven by wind or currents, is quiescent, while the glacier moves toward lower levels.

Thus Shackleton glacier is a great mother glacier into which drains the snow and ice from enormous areas of highland. The glacier collects the ice and transports it northward to the Great Ice Barrier, where it is dropped as bergs into Ross Sea.

TO FIND THE SIZE OF A STOP

A little practical difficulty often met with by the photographer accustomed to do his own odd jobs in connection with apparatus is the determination of the right size of a stop. Second-hand lenses are often without any Waterhouse stops, and when the right size for one stop has been found the diameter of the next one in the usual series generally necessitates the raking up of the old rule for obtaining a square root, which rule few can remember.

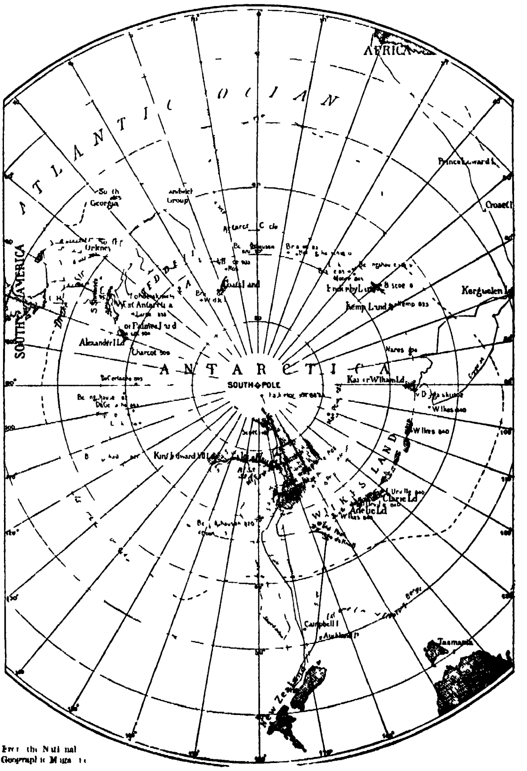
A writer in the Amateur Photographer points out a very simple geometrical method of solving this problem, well known to experienced workers, but not to the amateur camera fitter. This method is an easy application of the familiar forty-seventh proposition of the first book of Euclid, which teaches us that in a right-angle triangle the square on the side subtending the right angle is equal to the sum of the squares on the other two sides. If these other two sides are equal, it is obvious that the square on either one of them is equal to half the square on the longest side.

Therefore the ratio of one short side to the longest side is that of the diameter of two lens stops, one of which requires twice the exposure of the other. We, therefore, only need to draw a right-angled triangle with two equal sides, making one of these sides equal to the diameter of our known stop. The longest side facing the right angle is then equal to the diameter of the next largest stop. Having fixed two of the diameters, the rest are simple multiples of these two. Thus if we know the diameter of *f*/11 and find that of *f*/8 by the construction described, *f*/22 and *f*/44 are respectively half and a quarter of *f*/11, while *f*/16 and *f*/32 are half and a quarter of *f*/8.

After a thorough investigation and numerous conferences with railway men, the Indiana Railway Commission has issued an order to all of the railways in the State requiring that all locomotives used for passenger and freight service shall be equipped with headlight lamps of 1,500 candle power. The order does not specify that the lamp shall be electric or acetylene. During the investigation experiments with oil and electric headlights were made in the laboratory of Purdue University. While railway men with few exceptions opposed high power headlights, electric traction motormen were practically unanimous as to the advantages of high candle-power over the oil lamp. About 4,000 locomotives come under the order, of which one-third are to be fitted by January 1st, 1911, and the remainder by July 1st, 1911.

MYTH AND SCIENCE

TRADITIONS concerning so-called extinct animals still surviving in little known regions of the earth's surface are persistent enough to warrant the attention of men of science. Whether, however, the strange creatures spoken of by savages as haunting lonely lakes and forests are really survivals from the pre-glacial epoch is quite another question. According to that great authority on wild animals, Herr Carl Hagenbeck, an animal akin to the Brontosaurus, which is twin brother to the Diplodocus, is still alive in the fever-haunted swamps of Rhodesia; whether northern or southern we are not told. Many years ago the observer M. Inges, who is a very trustworthy authority, was informed by negroes of the existence of this huge saurian, and a recent writer in the Buluwayo Chronicle mentions the continuance of the tradition and adds many interesting details. Were the late Prof. Seeley, who above all other palaeontologists was an authority on South African fossil fauna, still alive, it would be interesting to hear his weighty opinion on the subject, if he has not already adverted to it in his book on dragons. The story has so far been treated as a rumor. Only recently private advices reached England that in the dense and gloomy forests of an island in the Malay Archipelago (we believe it is Ceram) there still exist monsters of a species long believed to be extinct. The news first reached Mr. Alfred Stalker, a young collector of natural history specimens, who, we understand, has done good work for leading museums both here and in Australia. Mr. Stalker was told that the monsters would be found two days' march in the interior and that they lived in water. He is said to have postponed his search for them, and now the melancholy news reaches us of his death by drowning. It is, of course, possible that the creatures are only tapirs. Readers of Mr. Andrew Lang's whimsical "Disentanglers" will remember that he chose Cagayan Sulu, one of the most southerly of the Philippine Islands, as the habitat of the mystic and mythic "Berbalang." It is to this island that the explorers in his story brought their finds—the giant sloth (mylodon) of Patagonia, the bunyip of Central Australia, the beathach of Loch Odha, the eggs of dinornis, the gorilla, and so forth. Now we know that the mylodon existed in times comparatively recent, for it has been found, and the Daily Express sent out an expedition to investigate the matter not many years ago. The bunyip rests apparently on the authority of Buckley, the convict who escaped from Port Phillip a century ago, lived long as a savage among primitive Australian blacks, and doubtless was the antitype of the ingenious M. de Rougemont, as Selkirk was of Crusoe. Still huge marsupials of the bunyip type may very well have existed in Queensland and Central Australia to times quite within the memory of persons still living. Sutherlandshire Celts have told Mr. Andrew Lang that in winter nights the beathach, a creature of immeasurable length, has been heard breaking up the ice in the lochs. Perhaps this creature is a diminutive one of the Pittsburg diplodocus, the skeleton of which is well known to us in the British Museum of Natural History. The dragon, the krakens, the many huge serpents of the Lesser Edda, a work compiled in the snakeless Iceland of the thirteenth century, are doubtless also mere memories lingering for ages in the primitive mind. Of their family is the sea serpent so solemnly reported upon in 1821 by William Clift, conservator of the Museum of the Royal College of Surgeons of England. This creature was perhaps a manatee. The mammoth again was long half mythic. Its tusks were sought for in Siberia, but the whole creature remained unknown until 180[illegible], when the well-preserved body of a mammoth was melted out of a large block of ice on the shore of Lake Oncoul, and though afterward partially devoured by packs of wolves was discovered in its entirety by a Tungoose ivory hunter, and in 1806 fully examined by Mr. Adams. The wild hunter at gaze before the mammoth was the subject of one of Ernest Griset's pictures, long in the possession of the late Sir Joseph Prestwich in his Shoreham home. To medicine these strange histories are of considerable interest, though few men of science believe in the possibility of the survival among us of animals belonging to the pre-glacial epoch.—Lancet.



From the National Geographic Magazine

SKETCH MAP OF THE SOUTH POLAR REGIONS

SOLAR VORTICES AND MAGNETIC FIELDS.—II.

RECENT STUDY OF THE SUN.

BY PROF. GEORGE E. HALE.

Concluded from Supplement No. 1787, Page 215

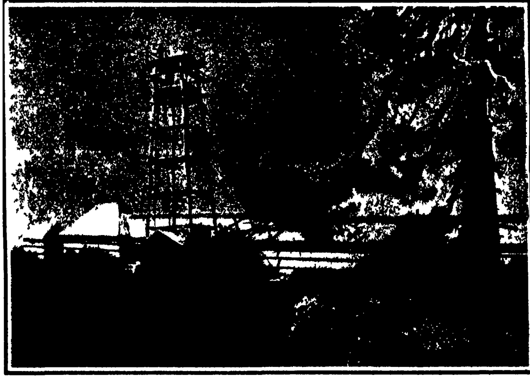


Fig. 5.—TOWER TELESCOPE ON MOUNT WILSON.

Fig. 7.—INTERIOR OF PASADENA LABORATORY.

View showing slit-end of vertical spectrograph and magnet used in the study of Zeeman effect.

I have already referred to the importance of applying to astronomical research the methods of the physicist. During the last quarter of a century the study of spectroscopic phenomena in the laboratory has been completely transformed. It may well be said that this transformation, which has involved such discoveries as spectral series, the effect of pressure on wave-length, and the Zeeman effect, has been directly due to the use of Rowland concave gratings of good focal length arranged for photography. In astronomical spectroscopy great advances have also been made, but the spectroscope has continued to occupy the place it formerly held as an attachment of the telescope. Although Rowland used a long-focus concave grating for his classic study of the solar spectrum, the heliostat and lens employed with this instrument gave so small a solar image on the slit that the investigation of sun-spots and other details was impossible. We thus see that while in the observatory the spectroscope continued to be used as an accessory of the telescope, in the laboratory the parts were exchanged and the telescope was employed simply as an accessory of the spectroscope. It seemed obvious that a great opportunity for advance lay open to the investigator who would combine a long-focus spectroscope with a long-focus telescope. As it would be difficult or perhaps impossible to use for photography a sufficiently long spectroscope attached to the tube of an equatorially mounted telescope, some form of fixed telescope was plainly essential.

The tower telescope on Mount Wilson (Fig. 5) is designed to accomplish this purpose. It consists essentially of a 12-inch refracting telescope of 60 feet focal length, mounted in a fixed position pointed directly at the zenith. The telescope tube is replaced in this case by a light steel tower. The 12-inch objective lies horizontally at the summit of the tower, and sunlight is reflected into it from the second of two adjustable plane mirrors. The first of these mirrors is mounted as a cœlostat and is rotated by an accurate driving clock about a polar axis at such a rate as to counteract the apparent motion of the sun. Thus a beam of sunlight is reflected from the cœlostat mirror to the second mirror, which sends it vertically downward through the objective. In the focal plane, 60 feet below the objective, an image of the sun about [illegible] inches in diameter is formed on the slit of a spectrograph at a height of about 3 feet above the surface of the ground. After passing through the slit the light of any desired portion of the solar image (a sun-spot, for example) descends vertically into a well about [illegible]0 feet deep excavated in the earth beneath the tower. Thirty feet from the slit the diverging rays encounter a [illegible] inch objective, through which they pass. After being rendered parallel by the objective the rays fall upon a Rowland plane grating ruled with 14438 lines to the inch. The grating breaks up the light into a series of spectra, and the rays are returned through the same objective, which brings the spectra to a focus at a point near the slit. By inclining the grating at a small angle the image of the spectrum is made to fall at a point slightly to one side of the slit, and here the photographic plate is placed. Thus a portion of the spectrum 17 inches in length can be photographed in a single operation. In the work on sun-spots most of the photographs are taken in the third order of the grating, where the dispersion and resolving power are very high. When the spot spectrum is being photographed only the light from the umbra is admitted to the slit. At the end of the exposure this portion of the slit is covered and light from the photosphere at a point removed from the spot is admitted to the slit on either side. Thus the narrow spot spectrum is photographed between two strips of solar spectrum used for comparison.

The advantages of this combined form of telescope and spectrograph are considerable. On account of the great thickness (12 inches) of the mirrors, the height of the cœlostat above the heated earth, and the use of a vertical beam, the definition of the solar image is always better than the Snow (horizontal) telescope. Another important advantage is the nearly constant temperature at the bottom of the well, where the grating is placed. This permits long exposures to be given when necessary without danger of such displacements of the spectral lines as would be caused by expansion or contraction of the grating. The grating used in this spectrograph is a small one, which I have employed in most of my work since 1880, but the unusual focal length of the spectrograph permits the full visual resolution of the grating to be utilized in photographic observations. Thus it has become possible to photograph the widened lines and doublets as well as a host of narrow lines, most of them due to chemical compounds which had not previously been recorded in the spot spectrum.

Lack of time prevents me from discussing in this lecture the various studies of sun-spot lines carried out with this instrument before the attempt to detect a magnetic field in spots was undertaken. An extensive catalogue of these lines is nearly complete, a preliminary map has been issued and a better one is in preparation, and a series of investigations with the arc and electric furnace has suggested that the strengthening and weakening of certain lines is due to a reduction in the temperature of the spot vapors. At present we are concerned with the cause of the widening and doubling of spot lines, and the method of testing this question must now be described.

A Nicol prism was mounted above the slit of the spectrograph, and just above this a Fresnel rhomb, If the components of a spot doublet were circularly polarized in opposite directions, passage through the rhomb should give two plane polarized beams, the planes of polarization making an angle of 90 deg. with each other. Thus in one position of the Nicol one of the components should be photographed alone, and by turning the Nicol 90 deg. this should disappear and the other component come into view.

When this test was applied with the tower telescope, in June, 1908, the true character of the spot doublets became apparent (Fig. 6). One or the other component of the doublet could be cut off at will by rotating the Nicol, precisely as Zeeman had done in the laboratory. On account of the unique character of the Zeeman doublets, this test alone was almost sufficient to prove the existence of a magnetic field in sun-spots. But one of the great beauties of the Zeeman effect is its many-sided character, which permitted the test to be multiplied and extended. From Zeeman's first experiments it was known, for example, that if the strength of the magnetic field is insufficient to separate completely the components of a doublet, the edges of the resulting widened line should be circularly polarized in opposite directions. Thus those lines which are widened but not doubled, in spots, might be expected to shift in position when the Nicol is rotated. This was found to be the case. Again, the lines which constitute the flutings of the spectra of compounds are not, in general, affected by a magnetic field. Hence such lines in the spectrum of a sun-spot should not be shifted when the Nicol is rotated. This also was found to be true. But a still more satisfactory test was suggested by another laboratory phenomenon. When a doublet is observed along the lines of force, with one of the components extinguished by the Nicol, reversal of the current through the magnet should extinguish the visible component and cause the invisible one to appear. In the sun, according to our hypothesis, reversal of the direction of revolution in a vortex should correspond to reversal of the current through the coils of a magnet. Hence the red component of a doublet should appear in the spectrum of a vortex rotating in one direction, the violet component in that of a vortex rotating in the reverse direction. Fortunately, the appearance on opposite sides of the solar equator of two spot vortices rotating in opposite directions (Fig. 4) made this test possible. The results were perfectly in accord with the hypothesis.

So far we have been considering only such phenomena as are observed parallel to the lines of force of a magnetic field; but a spectral line which in such circumstances, appears as a doublet is usually transformed into a triplet when the observation is made at right angles to the lines of force. The circularly polarised side components of the doublet give place to plane polarized components occupying the same position, while another line appears centrally between them. The light of this line is also plane polarized, the direction of the vibration being parallel to the field, while the vibrations of the side components are in a plane at right angles to the field. Thus when a spot is carried by the solar rotation to a point near the limb we might expect the double lines in its spectrum to be transformed into triplets if produced by a magnetic field. The failure of the central line to appear seemed to raise an important argument against the magnetic hypothesis.

At this point the necessity of conducting laboratory investigations in immediate conjunction with astronomical observations is well illustrated. Fortunately our laboratory was already well equipped for work of this nature (Fig. 7). In anticipation of the possibility that observations of the Zeeman effect would be needed in the interpretation of solar and stellar phenomena, a powerful electromagnet with suitable accessory apparatus had been provided. A brilliant spark produced between metallic electrodes in the field of the magnet furnished the source of light. As many of the double lines in sun-spot spectra are due to iron, this metal was selected for the first experiments. The spectrum was photographed at various angles with the lines of force with a powerful spectrograph like the one used with the tower telescope, similarly mounted in an underground chamber.

The difficulty of accounting for the behavior of the iron doublets in the sun was removed by these investigations. It appears that these lines do not become triplets when observed across the lines of force. In reality they are changed to quadruplets or doublets in which each of the components is a close double line. In the magnetic field of sun-spots, which is much weaker than the field used in the laboratory, the closely adjoining lines which constitute the components of the doublets cannot be separated. Thus these sun-spot lines should appear double at whatever position the spot may occupy on the sun's surface.

The distance between the components of doublets or triplets separated in the magnetic field varies greatly for different lines. Some exceptional lines are not affected in the least, others are merely widened, and others are clearly and sometimes greatly separated. It is therefore important to compare the widening and the separation of lines in a sun-spot spectrum with the corresponding phenomena in the magnetic field. With few exceptions, most of which may be accounted for by the presence in the spot spectrum of closely adjoining lines of other elements, the solar and laboratory results were found to be in good agreement. The following table gives a comparison of certain iron lines in the spot and laboratory:

Wave Length	Δλ Spark	$\frac{\Delta\lambda\ \text{Spark}}{5.1}$	Δλ Spot	
6213.14	0.703	0.138	0.136	—0.002
6301.72	0.737	0.144	0.138	—0.006
6302.71	1.230	0.241	0.252	+0.011
6337.05	0.895	0.175	0.172	—0.003

The column headed "Δλ, Spark" gives the distance between the components of the lines as observed in the laboratory. As the strength of the magnetic field used in the laboratory was about 5.1 times that of the spot, the quantities obtained by dividing the separations in the second column by 5.1 are given in the third column. These separations are directly comparable with the separations of the corresponding lines in the spot, which are given in the fourth column. The fifth column shows that the differences between the solar and laboratory results are very small. As the strength of the field in the laboratory was about 15 000 gausses, the strength of the field in this spot would be about 15 000 ÷ 5.1 = 2900 gausses. The strongest field hitherto measured on our photographs of spot spectra is about 4500 gausses, corresponding to a considerably greater separation of the lines (Fig. 8).

When a similar comparison was made for various lines of titanium and chromium, a much less perfect agreement between the spot and laboratory results was found. It had already been observed that such lines as *D* of sodium and *b* of magnesium, which undoubtedly represent a much higher level than the great majority of lines in the spot spectrum, are but very slightly widened. As these lines are strongly affected by a magnetic field in the laboratory, it appeared evident that the strength of the field in spots must fall off rapidly in passing outward through the spot vapors. In these circumstances lines of other elements which represent levels higher than the average should show small separations in the magnetic field of the spot. It seems probable that in this way the lack of perfect agreement between the laboratory and solar results observed in the case of titanium and chromium can be accounted for.

A further important test was afforded by the well-known phenomenon exemplified in Preston's law. According to this law, the distance between the components of the lines split up by a magnetic field varies directly as the square of the wave-length. This we found to be true even in the case of a metal like iron, the lines of which cannot be grouped into series, if the average separation of a sufficient number of lines were considered. We should therefore expect that the widening of lines in spots would rapidly decrease toward the violet, and that the separation of spot doublets should diminish in a similar way. A study of the spot spectrum shows that this actually occurs.

It soon appeared that the normal spot spectrum always contains triplets as well as doublets (Fig. 8). These are less easily recognized because the presence of the central line crowds the components so closely together that they are not readily separated with the resolving power available. As these triplets are photographed even when the spot is very near the middle of the sun, it is evident that the spot always sends out light which makes a considerable angle with the lines of force. In a normal triplet the central line is of twice the intensity of the side components when observed at right angles to the lines of force, and disappears altogether when observed parallel to the lines of force. Thus by determining the relative intensities of the central and side lines of such a triplet the angle between the lines of force and the line of vision can be obtained. In the case of sun-spots the data at present available are not sufficient for the accurate determination of this angle, but it seems to lie between 30 deg. and 60 deg. when the spot is near the center of the sun. On the hypothesis that the magnetic field is produced by the spot vortex, it would then follow that the axis of the vortex, instead of being radiant as we at first assumed, makes an angle of much less than 90 deg. with the surface of the photosphere.

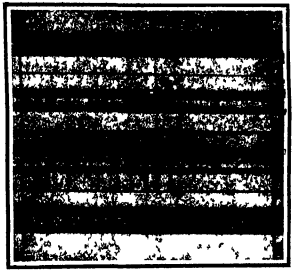


FIG. 6.

1. Southern spot showing red components of double lines, No. 1 20 W. 2. Northern spot showing violet components of double lines, No. [illegible] W. 3. Northern spot showing red components of doublets, Nicol 1 E. 4. Spot spectrum without Rhomb or Nicol showing both components of doublets.

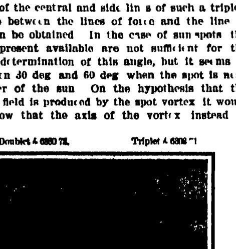


FIG. 8.

Iron doublet (λ 6301 72) and triplet (λ 6302 71) in two spot spectra, showing field strengths of 2900 and 4500 gausses respectively.

The time at my disposal permits me to describe briefly only a few other phases of this investigation. In the laboratory the central line of triplets is polarized in a plane parallel to the magnetic field. Hence if the light is passed through a Nicol prism used without a rhomb, it should be possible to extinguish this line at certain positions of the Nicol, in which case a spot triplet would appear as a doublet. This test has also been applied to the spot triplets with the expected result. In fact, this method supplies a convenient means of recognizing close triplets the components of which are too closely crowded to be seen separately before the central line is cut out. Indications have also been obtained of what may prove to be unequal rotation of the plane of polarization of this central line in different parts of spots. The gradual decrease in the strength of the field from the umbra to the outer limit of the penumbra has been studied, and magnetic fields have been detected on the sun's disk in certain regions outside of sun-spots. It is evident that many new phases of the subject are likely to be developed in the future, especially if larger images of the sun and more powerful spectrographs are employed. In this connection it may be stated that a tower telescope of 150 feet focal length, to be used on Mount Wilson with a spectrograph of 75 feet focal length, is now under construction. This will give a focal image of the sun about 16 inches in diameter, in which small spots as well as large ones can be studied.

Although it now seems to be demonstrated that sun-spots are solar vortices, judgment should be reserved as to the various theories which have been advanced to account for their origin. Many of the results I have described appear favorable to Emden's solar theory, but it seems to be opposed by the important investigations of Evershed, who has found that the metallic vapors in sun-spots flow radially outward from the umbra parallel to the photosphere. The further development of Evershed's work and the continued study of solar vortices and magnetic fields should soon permit a trustworthy theory of sun-spots to be formulated.

It is evident that the rapid decrease upward of the strength of the field in spots would prevent this field from having an appreciable influence on the higher solar atmosphere. At the distance of the earth, as Schuster has shown, the combined magnetic effect of several spots, all assumed to be of the same polarity and having no such rapid decrease in field strength at higher levels as is actually observed, would be altogether incompetent to account for terrestrial magnetic storms.

In concluding I wish to express my appreciation of the assistance I have received from my colleagues at Mount Wilson. I am particularly indebted to Messrs. Adams, Ellerman, King, Nichols and St. John for aid in connection with the present investigation.

GEESE THAT GROW ON TREES.

The barnacle or bernicle goose (*Branta bernicle*) is a sea fowl which rests and breeds on the coasts and islands of both hemispheres between 60 and 80 degrees of north latitude, and appears in great flocks in the Baltic and North seas in spring and autumn. In the Middle Ages this bird was asserted to be a vegetable product. This absurd fable is of Oriental origin. It first appeared in Europe in the "Otia Imperialia" or "Idle Hours," written by Gervase of Tilbury about the year 1211. Gervase asserts that bernicle geese are not hatched from eggs, but grow on trees, and describes a variety of willow growing on the shore of Kent near Faversham Abbey which produces knots that develop into geese. The birds hang suspended by their bills until they come to life and then drop off and plunge into the sea. Hence the flesh of the bernicle goose was eaten freely in Lent for centuries, and even after the Dutch traveler Gide Vera in 1599 described the breeding places of the birds, which he had discovered in Spitzbergen. According to another fable, which was reiterated with equal persistency and which has given this much maligned bird its popular name, it passed its early life in the form of a cirriped mollusk, the goose mussel or duck barnacle (*Lepas anatifera*), which clings in vast numbers to the bottoms of ships and greatly diminishes their speed.

A note in the Electrician refers to some tests on electric rolling mills carried out by Mr. Puppe, who has recently published results of accurate electrical measurements he has made on six electrically driven rolling mills. He arrived at these results by observing the energy given out at the mill and the speed of rotation, and by this means, by also taking into account the copper and no-load losses, he was able to calculate the useful work performed. The influence of temperature on the resistance of the material is exhibited by the increase of the latter as the billet cools. Large rolls require more energy with a small height of roller than do small rolls with a large height of roll. The strength of the material has no influence on the energy consumption, but this latter is increased from the fact that the harder the material the lower the temperature at which it must be worked. A drop in temperature of 70 deg. causes an increase in the energy consumption amounting to between 20 and 30 per cent. The spread of the material in a horizontal direction has a disadvantageous effect on the energy required. With a small number of passes the aggregate load on the motor is only from one-quarter to one-fifth of its total capacity, but this is much more when there are many passes and the billets are wide.

HALLEY'S COMET.—I.*

BY FAR THE MOST INTERESTING OF THE PERIODIC COMETS.

BY GEORGE F. CHAMBERS, F.R.A.S.

The comet known as Halley's may be regarded as by far the most interesting of all the comets recorded in history, and this whether looked at from the standpoint *of the historian or of the astronomer*; and having regard to the position which it has occupied during many centuries in the public mind, and is likely also to occupy during the year 1910, it will be worth while to review its career in some detail.

A few years after the advent of the celebrated Comet of 1680 Sir I. Newton published his epoch-making "Principia," in which he first promulgated the Theory of Gravitation and applied it to the orbit of that comet. He explained the method of determining by geometrical construction the visible portion of the path of the comet, and invited astronomers to apply these principles to the comets on record or some of them. He considered that it was very probable that some comets might move in elongated ellipses which near perihelion would scarcely be distinguishable from parabolas, and he even thought that the recent Comet of 1680 might be moving in an ellipse the circuit of which would occupy about 575 years. Halley (to whose exertions the publication of the "Principia" was in great measure due, for he bore the labor and expense of its publication) also took this view. Although we now know that the period of that comet is measured by thousands of years, Halley's investigations were not without good fruit, for they may be said to have drawn him into a systematic study of cometary orbits which ended, as we shall soon see, in a famous and remarkable prediction. He undertook to investigate the movements of a large number of comets previously recorded with the view of ascertaining whether any, and if so which of them, had appeared to follow the same path. Careful investigation soon showed that the orbits of the comets of 1531 and 1607 were similar to each other and similar in fact to that of the Comet of 1682 seen by himself.

On August 15th, 1682, Flamsteed's assistant at the Royal Observatory, Greenwich, discovered a comet. A few days later the diameter of the head was about 2 min. of arc and it had a tail [illegible] deg. long. On August 21st the tail had become 10 deg. long. Flamsteed's observations seem not to have extended beyond September 9th, when the head had become enfeebled and was scarcely visible in the twilight. Halley himself, however, saw it a day later. Picard at Paris found the comet on August 26th, the head shining as a star of magnitude 2. On August 29th the tail was curved, the concavity being on the east side. On September 11th the head was so confused that it was only with difficulty that a luminous point could be perceived. Picard's last observation was on September 12th. Hevelius at Dantzig says that the comet was bright at the end of August and could be seen all night with a tail from 12 deg. to 16 deg. long. In large telescopes a nucleus of an oval or gibbous form was constantly noticed. It was also remarked that on many occasions the direction of the tail was not exactly *from* the sun, as P. Apian's observations of earlier comets suggested. The most remarkable of the matters mentioned by Hevelius was the existence of a luminous ray or sector thrown out from the nucleus into the tail. He has left behind a picture of this.

This ray was first noted about September 8th, and even making every allowance for the vagaries of the astronomical artists of the 17th century, it is impossible to doubt that some sort of ray of light was thrown out from the head of the comet, and we shall presently see that the same thing happened in 1835. The Comet of 1682 seems to have been very generally observed by all the principal astronomers of the time, and among those who have left behind them observations we find the familiar names of Kirch of Leipzig and Montanari of Padua, and the less familiar names of Zimmermann of Nuremberg and Baert of Toulon.

Halley, making use of Flamsteed's observations, calculated parabolic elements of the comet in accordance with the rules laid down by Newton, and having also determined by the same methods the orbits of the Comets of 1531 and 1607, he was immediately struck by their similarity and suspected from the like situation of their planes and perihelions that the comets which appeared in the years 1531, 1607 and 1682 were one and the same comet that had made three revolutions in its elliptical orbit. This supposition implied that the comet's period was somewhere about 75½ years. There were, nevertheless, two circumstances which might be supposed to offer some difficulty, inasmuch as it appeared that the intervals between the successive returns were not precisely equal, and that the inclination of the orbit was not exactly the same in each case. Halley, *however*, with a degree of sagacity which, considering the state of knowledge at the time, cannot fail to excite unqualified admiration, observed that it was natural to suppose that the same causes which disturbed the planetary motions would likewise act on comets. In other words, that the attraction of the planets might be expected to exercise some disturbing influence on the motions of comets. The discrepancies already pointed out in the orbits of the three comets just mentioned made Halley hesitate for some time as to their identity, and in his memoir on comets published in 1705 he only, as it were, hinted his suspicions. Eventually, however, he became much more confident. This appears to have been the result of his investigations as to the probable influence of the planet Jupiter. He found that between 1607 and 1682 the comet had passed so near Jupiter that its velocity in its orbit must have been considerably augmented and its period consequently shortened. He was therefore induced to *predict* its return about the end of 1758 or the beginning of 1759. Finally, when he had matured his labors he thus plaintively wrote on the subject: "Wherefore if it should return according to our prediction about the year 1758 impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman." On this Hind judiciously remarked as follows: "Nor has posterity attempted to deprive him of the honors which were his due. His discovery forms an epoch, and an important one, in the history of astronomy. His calculations must have been laborious in the extreme. He assures us himself they were prodigiously long and troublesome, but the zeal which induced such an amount of exertion was well rewarded by the final result."

EDMUND HALLEY.

Halley's first formal announcement of his expectations concerning his comet appears to have been in the paper presented to the Royal Society in which the following passage (in Latin) occurs: "Now many things lead me to believe that the Comet of the year 1531 observed by Apian is the same as that which in the year 1607 was described by Kepler and Longomontanus and which I saw and observed myself at its return in 1682. All the elements agree except that there is an inequality in the time of revolution, but this is not so great that it cannot be attributed to physical causes. For example, the motion of Saturn is so disturbed by other planets and especially by Jupiter that this periodic time is uncertain to the extent of several days. How much more liable to such perturbations is a comet which recedes to a distance nearly four times greater than Saturn, and a slight increase in whose velocity could change its orbit from an ellipse to a parabola. The identity of these comets is confirmed by the fact that in the summer of the year 1456 a comet was seen which passed in a retrograde direction between the Earth and the Sun, in nearly the same manner, and although it was not observed astronomically, yet from its period and path, I infer that it was the same comet as that of the years 1531, 1607 and 1682. I may, therefore, with confidence predict its return in the year 1758. If this prediction be fulfilled there is no reason to doubt *that the other comets will return*."

Halley died in 1742 and was buried in the Churchyard at St. Margaret's, Lee, not far from Greenwich, and it has lately (1909) been announced that the Admiralty have decided to repair his tomb at the public expense, no descendants of his being known. The original top slab with an inscription was illegally removed to the Greenwich Observatory in 1854. Let us hope that it will be now restored or a new one with the original inscription put in place.

As years rolled on and 1758 began to draw near, astronomers naturally recalled Halley's prediction and thought it worth while to rely upon it in making preparations to receive the comet. The French astronomer Clairaut was the man who took the matter most seriously in hand, the important question being to ascertain the extent of the perturbations of the comet's orbit likely to be brought about by the influence of Jupiter and Saturn. The history of the steps taken cannot be better described than in the words of Hind: "Having devised a method which appeared to possess all needful accuracy, he commenced, in conjunction with the celebrated Lalande and a lady, Madame Lepaute, the immense mass of calculations requisite for the complete attainment of his object. It was necessary to compute the distance of the comet from the disturbing planets Jupiter and Saturn not only from 1682 when it was last observed, but for the previous revolution, or for a space of more than 150 years. This of itself was a most laborious business, but the succeeding part of the work, where the disturbing force of each planet was required for this long period, involved much greater and more intricate calculations. Lalande minutely describes the plan adopted; for six months they computed from morning to night with but little intermission, even, as he states, at meals, and he mentions as one result of this assiduous attention to the work that he contracted an illness which remained upon him during the rest of his life. Madame Lepaute's assistance is said to have been so important that without it they would hardly have completed the investigation before the comet reappeared. However, by dint of these extraordinary exertions the calculations were brought to a close."

On November 14th, 1758, Clairaut announced in a paper addressed to the Academy of Sciences at Paris, that by the influence of Jupiter the comet would be retarded 518 days and that to this must be added 100 days due to Saturn, so that the total retardation would be 618 days or about 20 months. On this basis he predicted April 13, 1759, as the date of the coming perihelion passage. He did this, however, with a slight reservation because, having neglected some small quantities in the calculations, he thought that the date named might be wrong by a month either way. When Clairaut's conclusions became generally known the astronomers of Europe were soon on the *qui vive*, and several of them carried out a prolonged watch of the heavens, which in Messier's case extended over the whole of the year 1758. It was not destined, however, that a professional astronomer should be the first to detect the comet on its anticipated return; that honor was reserved for an amateur student of nature, said to have been a farmer by occupation, named Palitzsch, living at Prohlis near Dresden, who saw it on the night of Christmas day 1758 with a *telescope of 8 feet focus*. Some curious misstatements respecting this man have been widely circulated, and perhaps even to this day may be considered as still in circulation. Baron de Zach, who was personally acquainted with the man, has left on record some interesting particulars relating to him. Farmer though he was, he was a diligent student of astronomy, was possessed of a strong sight, and was in the habit of scrutinizing the heavens with the naked eye, which may perhaps have given rise to the statement that he found Halley's Comet with the naked eye at a time when the professional astronomers were vainly searching for it with their telescopes. The first man of note to find the comet appears to have been Messier, who caught it in bad weather on January 21st and observed it regularly for three weeks. It seems that Delisle, then Director of the Observatory of Paris, would not allow Messier (who was his assistant) to disclose the fact of his discovery, and he remained the only professed astronomer who saw the comet before it became lost in the sun's rays at its perihelion passage. Let us hope that Hind's remark on this incident will remain true: "Such a discreditable and selfish concealment of an interesting discovery is not likely to sully again the annals of Astronomy." This strange conduct of Delisle's carried its own punishment, for when Messier's observations were afterward published some members of the French Academy treated them as forgeries, but there appears to have been no sufficient ground for this imputation, and it was eventually withdrawn. It remains to be added that the comet passed its perihelion on March 12th, 1759—just within the limits assigned by Clairaut. After that, it was seen throughout Europe during April and May, although to the best advantage only in the Southern Hemisphere. On May 5th it had a tail 47 deg. long.

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* The Story of the Comets Simply Told for General Readers. By George F. Chambers, F.R.A.S. Oxford at the Clarendon Press, 1909.

Previous to the return of the comet in 1835, numerous preparations were made to receive it.

The great progress which had been made since 1759 in telescopes and methods of observation, especially under the inspiration of the two Herschels, Sir William and Sir John, and also in mathematics applied to celestial motions by men like Laplace, Lalande, La Grange, and other eminent foreigners, rendered the study of the movements of this comet, both visually when the time came to see it, and mathematically, before that time, a problem of great interest. As long before the expected return of the comet as 1817 the Academy of Sciences at Turin offered a prize, open to astronomers of all nations, for an Essay on the perturbations undergone by the comet since 1759. Baron Damoiseau of Paris gained the prize, and his essay was published in 1820 in the Memoirs of the Turin Academy, vol. xxiv. The following outline of the researches of Damoiseau and others is epitomized from Hind's statement of them.

After calculating the effects of the attraction of the larger planets he fixed November 4th, 1835, at 8 P. M., Paris M.T., as the moment of the comet's perihelion passage. After Damoiseau, another Frenchman, Count de Pontécoulant, took up the matter, more or less on the same lines as Damoiseau, with the result that his date for the perihelion was rather more than a week later than Damoiseau's, or to be exact, he fixed the perihelion for November 12th, at 17^{h}, Paris M.T. The investigations both of Damoiseau and Pontécoulant were in a sense defective because both of them had omitted to take account of certain of the planets whose influence counted for something. Accordingly a German computer Rosenberger of Halle, started on a new and independent investigation. Damoiseau and Pontécoulant had neither of them attached sufficient importance to the actual ellipse described by the comet in 1759. As 1759 was the starting point from which to determine the probabilities of 1835, it was important to obtain the most accurate knowledge possible of the condition of things in 1759. Rosenberger thought that he ought to go much further back than either Damoiseau or Pontécoulant had done, and that it would be impossible to make a trustworthy prediction for 1835 unless he began as far back as 1682, and computed the perturbation between 1682 and 1759, and so led up to 1835.

In performing his task Rosenberger took account not only of the influence of the great planets Jupiter, Saturn, and Uranus, but also of the smaller influence exerted by Venus, the Earth, and Mars, with some allowance also for Encke's supposed Resisting Medium as affecting his (Encke's) Comet. Omitting in the first instance any allowance for a Resisting Medium Rosenberger named November 11th, at 0h. Paris M.T., for the comet's perihelion passage. If an allowance supposed to be appropriate were made for a Resisting Medium the perihelion would fall about a week earlier or on November 3d at 19^{h} Paris M.T. The actual effects on the comet's motion ascribed to the smaller planets were as follows: the Earth 15.23 days, Venus about 5.13 days, and Mercury and Mars together nearly 1 day. By these periods of time (namely, about 22 days) added together, Rosenberger considered that the comet's return would be hastened. "Professor Rosenberger's investigation is remarkable for its extraordinary completeness, for the pains taken to include every possible source of perturbation, without regard to the numerical labor, and for the masterly manner in which the whole of the vast work was conducted."

Rosenberger, however, had a competitor in his own country. Lehmann thought there was room for another discussion of the elements and disturbances of the orbit of Halley's comet, and though his labors were not in some respects as meritorious as Rosenberger's they have a merit of their own, inasmuch as Lehmann took the year 1607 as his starting-point. On this basis he fixed November 26th for the perihelion passage, which was a date a fortnight later than Pontécoulant's and three weeks later than Damoiseau's.*

As early as December, 1834, astronomers began to direct their telescopes to that part of the heavens where it was supposed that the comet would be first seen. Olbers had thrown out suggestions that it might be possible to find the comet between December, 1834 and April, 1835, notwithstanding that the perihelion passage would not take place till many months later. Olbers' suggestion was largely acted upon, for it applied to the constellations Auriga and Taurus which were very favorably placed for observation in Northern and Central Europe, while Sir John Herschel at the Cape employed his great reflector also in sweeping for the anxiously expected body. But all these early efforts were wasted.

It was not until the morning of August 6th that the first view of the comet was obtained, and the fortunate man was Dumouchel, director of the Collegio Romano Observatory at Rome, using a powerful telescope in a splendid climate. The comet was close to the computed place which was near ζ Tauri. It was a faint, misty object, discernible with difficulty, and moonlight and unfavorable weather during the next following days delayed the comet's discovery elsewhere. However, on August 21st W. Struve found it with the great telescope at Dorpat, and during the following week it was seen at all the principal English and Continental observatories. The Dorpat observations showed that Rosenberger's predicted place was only seven minutes of arc wrong in R. A. and 17 minutes in Declination. The effect of this error was to retard the perihelion passage till November 16th, or five days later than the epoch fixed upon by Rosenberger. During the first three weeks of September the comet's brightness gradually increased, and on the 23d it was seen with the naked eye by Struve and on the following day with the naked eye by Kaiser at Leyden though it was not sufficiently bright to attract general notice till the end of the month. A tail was first seen on September 24th, and during October the comet was more or less conspicuous, but observers differed very much in their estimates of the maximum length of the tail. The average of the estimates would seem to have been from 20 deg. to 25 deg., though one observer did put it at 30 deg. The comet was lost to view about the time of perihelion passage disappearing below the S. W. horizon, and having, according to most accounts, lost its tail before the comet itself was lost to view. After the perihelion passage the comet was again observed at some of the southern observatories of Europe and at the Cape of Good Hope from December 30th to the middle of May, 1836.

Smyth's observations deserve to be quoted. Under the dates of October 10th and 11th he wrote:

"October 10th. The Comet in this evening's examination presented an extraordinary phenomenon. The brush, fan, or gleam of light, before mentioned, was clearly perceptible issuing from the nucleus, which was now about 17 seconds in diameter and shooting into the coma, the glances at times being very strong, and of a different aspect from the other parts of the luminosity. On viewing this appearance it was impossible not to recall the strange drawing of the 'luminous sector' which is given by Hevelius in his 'Annus Climactericus' as the representation of Halley's Comet in 1682 and which had been considered as a distortion.

"October 11th. The tail was increasing in length and brightness, and, what was most remarkable, in the opposite direction to it there proceeded from the coma across the nucleus a luminous band or lucid sector more than 60 sec. or 70 sec. in length and about 25 sec. broad, with 2 obtuse-angled rays, the nucleus being its central point. The light of this singular object was more brilliant than the other parts of the nebulosity and considerably more so than the tail, it was therefore amazingly distinct. On applying as much magnifying power as it would bear, the nucleus appeared to be rather gibbous than perfectly round but with the strange sector impinging it was a question of difficulty."

The observations made at the Cape of Good Hope by Maclear disclose a remarkable succession of phenomena. Though the perihelion passage took place on November 15th, 1835, Maclear did not begin to see the comet, or at any rate to record what he saw, till January 24th, 1836. He says that the alteration of form which had taken place between the beginning of November and this date, during which interval the comet had been lost in the Sun's rays, was "remarkable" and he goes on as follows.

"January 24th. To the naked eye it was as bright as a star of the 2.3 or third magnitude; there was no tail. In the 14 feet reflector, it presented an opaque, circular, planetary disc, tolerably well defined, encompassed by a delicately bright coma or halo, which was likewise circular.

"Crossing the disc in a direction not deviating much from parallelism with the equator, appeared an oblong, elliptical body, distinguished from the rest of the disc by its superior whiteness, and a semblance of greater density. The diameter of the disc measured 2 min. 11 sec., of the coma, 8 min. 12 sec.

"On the 25th, the circularity of the preceding limb of the cometary disc was particularly broken, its dimensions were increased, the elongated portion was better marked, and its following end was brighter than the preceding.

"On the 26th, the halo had diminished, and the dimensions of the disc, or body, as it should now be called, were further increased. A spot like a nucleus could be occasionally seen in the brighter end of the oblong portion.

"On the 28th the halo or coma had vanished. The nucleus was distinct like a faint small star in the following end of the oblong portion. The dimensions of the body had greatly increased while the intensity of its light had proportionately diminished. The general outline of the cometary body seemed approximating to a parabolic curve, the preceding end of which might be represented by conceiving the tail, as seen before the perihelion passage abruptly separated from the head, leaving a serrated or ragged outline. The oblong portion with the nucleus resembled a small comet inclosed in the body of a larger one.

"On the 30th the body was rather more elongated. A line drawn transversely through the nucleus measured 11 min. 42 sec. being 5 times the diameter on the 24th; or 29 times the area of a circle of which 2 min. 11 sec. is the diameter. But the visible area of the whole body on the 30th could not be less than 35 times that of the 24th excluding the halo. The nucleus was nearer to the S. than to the N. side by 32 sec.

"Throughout the succeeding three months the coma went on increasing until the outline finally became so faint as to be lost in the surrounding darkness, leaving a blind, nebulous blotch with a bright center enveloping the nucleus of variable brightness depending on moonlight or the state of the atmosphere, and variable distance."

(To be concluded.)

THE LOW COST OF REINFORCED CONCRETE CHIMNEYS.

MR. E. R. MATTHEWS in a paper on reinforced concrete chimney construction recently pointed out that among the important advantages of reinforced concrete chimneys are the lower cost, the saving of space, and the rapidity of erection. In the United States it has been found that reinforced concrete chimneys cost less than half as much as brick shafts, the saving being greater the larger the shaft. With regard to saving space, while a brick shaft 300 feet high, would be 4 feet 10 inches thick at the base, the dimensions at the base of a concrete chimney of the same height would be: Outer wall, 9 inches, inner wall, 5 inches, intermediate space, 4 inches. From a series of tests on the effect of high temperatures on reinforced concrete, it was found that the strength of briquettes of neat cement after exposure to a high temperature, was greater than that of similar briquettes kept in water. With concrete composed of 3 parts of sand to 1 of Portland cement, after allowing to set for 14 days in air the strength diminished very considerably on exposure to a high temperature, but when the concrete was allowed to set for two months, it was not affected in the least when subsequently exposed to a temperature of 900 deg. F. This latter temperature may be taken as the safe limit in reinforced concrete chimneys. Heat should not be applied to concrete until the latter has set for two or, preferably, three months. It is essential also to ensure that the concrete is free from voids.

According to the Electrical Engineer Dr. A. Koepsel has invented an apparatus for determining the composition of a gaseous mixture by estimating its electrical resistance. The apparatus is said to be specially applicable to the determination of the amount of hydrogen in water gas and of carbon dioxide in flue gases. The principle of the method is to employ a constant current to heat a wire passing through a tube filled with the gas to be analyzed. It is obvious that the temperature of the wire will vary inversely as the conducting power of the surrounding medium, and it is said that it affords a good means of ascertaining the quantitative composition of a mixture when it is known what gases are present, and when the temperatures attained in mixtures of known quantitative composition have been previously ascertained. We may remark, states our contemporary, that there is one great difficulty. The conducting power of all gases except hydrogen is very low; they differ, therefore by small quantities. Hence reliable results must depend upon great accuracy in the measurement of the temperature of the wire. This is presumably estimated from its resistance and it is doubtful whether it can be determined sufficiently exactly.

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* The distracting effect of planetary perturbations on the movements of comets is shown by the fact that whereas the interval between the perihelion passages of Halley's comet in 1835 and 1910 is to be set down at 74 years 5½ months (the shortest on record), in 1222 and 1301 it was 79 years 2 months (the longest on record, the next longest having been 1066 and 1145).

SCIENCE NOTES

Chlorine gas is produced by a process patented by F W Bartelt in small quantities, either alone or mixed with air as a bleaching mixture for laundry use For this purpose water is allowed to drop at intervals upon a dry mixture of bleaching powder and crystals of an acid or an acid salt, 1 part of bleaching powder to 2 parts of sodium bisulphate being specially suitable The apparatus preferably comprises a lower chamber, with detachable bottom, and an upper chamber, forming a stopper a turn of which opens suitable passages for the admission of water from the upper to the lower chamber and for the entry of air if desired The ingredients are introduced into the lower chamber in a removable tray

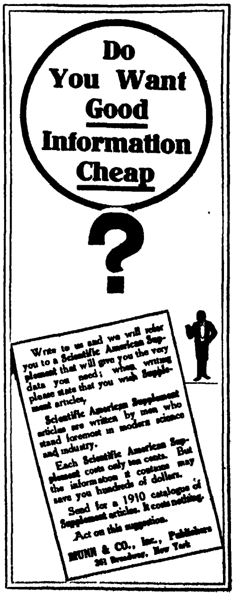
Suppose we have a phenomenon in which chance is involved, and that two events are equally likely, such as throwing head or tail with a coin Suppose we have a vertical board in which are stuck horizontal pegs in a regular arrangement of rows and columns Suppose a shot be dropped over the middle of this array of pegs and assume that if it strikes a peg it is equally likely to drop to the right or the left The next time it strikes a peg the chances are the same. It is obviously very unlikely that a shot will continually fall on the same side, while the likeliest thing that can happen is that it shall fall in the middle Hence if a large number of shot are let fall they will be found, if caught where they fall, to be arranged in a form limited by a curve highest in the middle, and gradually falling symmetrically toward both sides, known as the curve of errors This curve represents graphically the result of an infinite number of causes acting, each as likely to produce a certain effect as its opposite Take some biological subject of investigation, say the length of a certain kind of shell Many thousands being measured, it is found that they vary from the average, but in such a way that very few differ very far from the mean. If the number having any given length is plotted vertically corresponding to the deviation from the mean laid off horizontally, we shall obtain a curve which will generally closely resemble the curve of errors If this is the case we shall conclude that the causes of the variations in length are perfectly at random, but if we find that the curve is unsymmetrical, or for instance has two summits, we shall know that at least two sorts of causes are acting Thus questions of heredity and variation may be mathematically studied. This method has been greatly developed by the mathematician, Karl Pearson, who has now devoted himself to the study of evolution by mathematical means

If a bacterial culture be inoculated into a jelly with the point of a needle, it will be seen under the microscope to grow in all directions from the original center, and if pains are taken to insure the physical homogeneity of the jelly the shape of the colony will be an almost perfect circle If the diameter of this circle be measured at regular intervals, I have no doubt that a quantitative law of growth can be deduced, and even a differential equation found, which will turn out to resemble that of certain physical phenomena, say the conduction of heat The instruments and methods of the physiologist and the experimental psychologist are already largely physical, and their researches are carried on in laboratories. In proportion as the various circumstances are rendered more amenable to external control, so the methods of biology will more nearly approach those of physics. Whereas biology was until recently chiefly a science of observation, it has now become in a high degree experimental The physiologist removes or alters organs, removes eggs from the natural parent and places them in a foster mother, cuts off the heads and tails of worms and observes the conditions of survival and regeneration If the force of gravity were removed, in what direction would a plant grow? If an egg be subjected to centrifugal force, in which direction will the head of the animal appear? These are the sort of questions that the biologist is now attacking Nor is he without mathematical statements The great generalization of Darwin of fifty years ago has ever since concentrated attention on problems of development and heredity Darwin's conclusions were the results of the observations of a long life Now the experimental method enables one to hasten and accelerate conclusions The gentle monk and acute man of science, Gregor Mendel forty years ago in his cloister at Brünn by his careful experiments on the crossing of thousands of peas and by comparisons of their seeds, flowers and stems succeeded in unveiling a law which has profoundly influenced ideas on heredity, not only in plants but in animals He finds that in the process of hybridization there are certain characteristics which are transmitted entire to the offspring, and are termed dominant, others which seem to disappear or become latent in the process, which he terms recessive When however the hybrids are bred together both qualities reappear in the offspring, and in a definite proportion of three of the dominant to one of the recessive In the next generation another definite proportion occurs, and so on. We here have a very definite arithmetical relation, which is susceptible of very exact study and confirmation. The method of Mendel, which we may call that of experimental evolution is now of wide application, and there are laboratories which do nothing else but breed and cross under very exact control. Among one of the large-scale experimenters in this line may be mentioned Mr Luther Burbank, who, though a master of method and subsidized by the Carnegie Institution, seems to be devoted rather to practical than to scientific results

ENGINEERING NOTES.

In a recent number of Comptes Rendus, C Hautier compares theoretically, by diagram and well known formulæ, the adiabatic and isothermic compression and expansion of air to direct attention to the advantage of the former method, an advantage which, on the score of work utilized, is considerable In his application the maximum pressure is limited to 15 atmospheres, the temperature of which is 363 deg. Cent, and the compressed air has very nearly that temperature in the receiver This application is carried out on a gasoline motor car, with a view to giving to the motor couple, on transmission, the value of that of a steam engine, and without employing the usual clutches and speed changing gear The gasoline motor acts through an epicycloidal train differentially upon the transmission and an air compressor, and the compressor progressively brakes the exterior portion of the train. The air from the compressor is utilized immediately in a motor, and counterbalances the couple of resistance of the apparatus. As the speed increases, the effect of the air diminishes until it becomes *nil*, and the car is propelled directly by the motor.

K. Schreber in a recent number of Revue Générale des Sciences says that it is possible to obtain a large thermal return from a gas engine in which a volatile liquid is injected during the period of compression. This subject is examined (1) with reference to the use of water, (2) with reference to the thermo-dynamic calculations involved, and (3) by comparing the Banki motor with the Schreber system Since Lenoir's day water has been injected at each stroke of the piston to lower the temperature, to lubricate the surfaces, and to increase the gaseous pressure by the addition of the steam formed, but these are in great part visionary as benefits In result Schreber divides the compression period into three portions, in the middle one of which alone he injects the liquid so as to simply control the temperature and keep it below the igniting point of the mixture. Examination of various liquids leads him to the conclusion that alcohol is the most suitable, and that the best two-cycle engine is one worked with that liquid, and having a pump for a scavenging charge of air.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TRADE NOTES AND FORMULÆ.

To Color Bristles and Hair Black.—Make a paste of 2 parts of slaked lime and 1 part litharge, with the aid of soap boiler's lye, with which the hair or bristles must be rubbed. After 24 hours the coloring is complete. The hair or bristles must then be washed until the paste is thoroughly removed from them.

Preserving Fluid for Bodies and Plants.—Dissolve, in 300 parts of boiling water, 100 parts of alum, 25 parts common salt, 12 parts saltpeter, 60 parts potash, and 10 parts arsenious acid. Cool and filter the solution To 10,000 parts of this fluid, add 4,000 parts of glycerine and 1,000 parts of methyl alcohol.

Chartreuse Liqueur Essence.—25 parts orange peel oil, 15 parts neroli oil, 10 parts palm oil, 10 parts genuine cinnamon oil, 25 parts oil of lemon, 15 parts Angelica oil, 5 parts oil of wormwood, 5 parts oil of nutmeg, 1 part rose oil, 5 parts oil of coriander, 100 parts essence of violet blossoms, 50 parts pine apple ether, 1,734 parts alcohol To be colored a golden yellow.

Burns.—First wash the burns with an antiseptic solution (preferably with a solution of boracic acid 1 30), then bind them up with antiseptic paper containing 1 per cent of boracic acid, and which has been dipped in a concentrated solution of cocaine (1 15 or ½ hydrochlorate cocaine). Over this a light covering of lint. Leave it alone for four days, or longer.

Embalming Fluid for Animals and Corpses.—Dissolve 80 parts of potash, 60 parts of common salt, 80 parts of saltpeter, and 160 parts of alum in 6,000 parts of water which has been heated to 122 deg. F To this add a second solution of 18 parts of salicylic acid in 600 parts of methyl alcohol. To this mixture is then added 60 parts of carbolic acid and 1,800 parts of glycerine.

Bronze Alloys for Bronze Powder.—

	Copper.	Zinc.	Tin
Bright gold	84.5	15.5	. .
Red gold	90.00	9.6	0.4
Orange red	98.9	1.0	0.1
Copper red	99.9	0.1	. .
Purple red	99 3	0.5	0 20
Pale yellow	82.8	17.0	0 20

Imitation Boule Furniture.—The furniture surfaces, originally made in various kinds of wood, at the places where metallic plated effects are to be obtained, are coated with a mixture consisting of graphite and gum arabic or graphite and water glass, applied in sgraffito style, and then exposed to an electroplating bath, by which means the desired metal—copper or silver—can be deposited on the graphited places. This is afterward polished with a steel burnisher and then covered or protected by a suitable varnish (copal varnish).

To Cleanse Bath Sponges.—1. Unused sponges Turning them repeatedly, they should be beaten with a little wooden stick, to remove any sand they may contain, then they are laid in 0.5 to 1 per cent hydrochloric acid several times until no more lime is dissolved. Next they should be gently squeezed out and placed in a permanganate of potash solution (1 part to 2 parts per thousand), allow them to lie in it for ¼ to ½ an hour, press them out again and then place them in an aqueous solution of sulphurous acid (the latter dissolved from acid sulphite of soda in water) and hydrochloric or sulphuric acid added (small quantities) sulphuric acid mixed with sulphurous acid (for large quantities). After 15 minutes, squeeze the sponges out and place them in 2.5 to 5 per cent hydrochloric acid until the remains of the peroxide of manganese still adhering to them are removed. They are now of a straw yellow color; if it is desired to have them still lighter, the entire process is repeated, the sponges are then rinsed, pressed out, and dried at a moderate temperature. Brown spots may be removed by laying the cleansed sponge in a 20 per cent oxalic acid solution for a longer period. The sponge is now almost white or yellowish white, after drying in the air. If they should look somewhat brown, on account of their contact with alkalis, lay them for a time in weakly ammoniacal water, to which some peroxide of hydrogen has been added. 2. Used sponges: To be treated at certain intervals. First of all, the fatty substances are removed by repeated soaking of the sponges in 1 to 2 per cent carbonate of soda solution, at about 120 deg. F. (no concentrated or boiling solutions); finally, also, in aqueous or alcoholic ammonia. Bleach as above.

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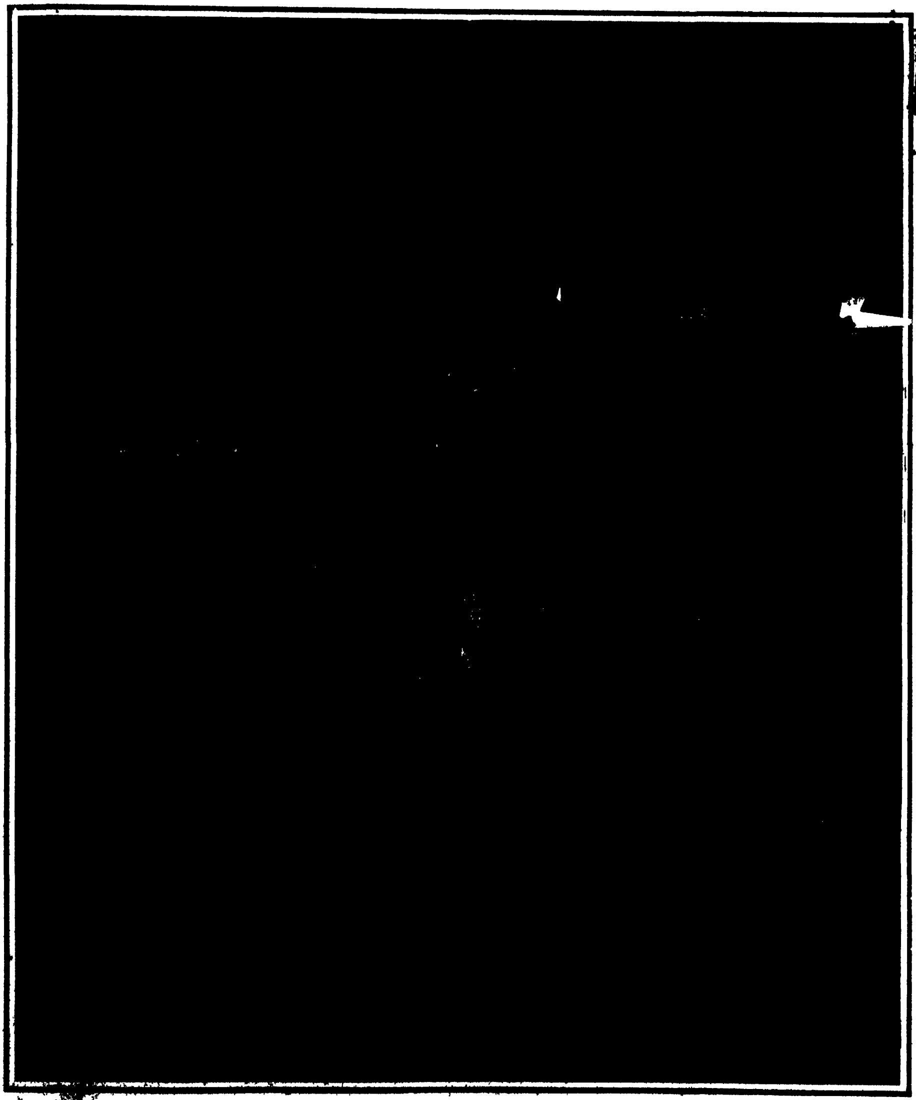

A TOTEM POLE, ALERT BAY, VANCOUVER ISLAND.

WOODEN MONUMENTS OF THE NORTHWEST COAST INDIANS.—[See page 248.]

ALCOHOL FROM WOOD WASTE.*

ITS CHEMISTRY AND PROCESSES.

BY PROF. R. F. RUTTAN, M. D.

The action of the zymase of yeast upon glucose and certain other fermentable sugars is the one source of the ethyl alcohol of commerce. It therefore follows that the problem of how to produce ethyl alcohol in a more economical manner can only be solved by finding a new and cheaper method of obtaining solutions of fermentable sugars.

The fermentable sugars employed in the preparation of alcohol have been derived hitherto from a number of sources which may be generally stated to be (1) the products of the hydrolysis of starch and allied substances by means of an amylase; (2) solutions of sugar obtained directly from fruits, etc., and the non-crystallizable by-products of sugar works, etc.

The cost of alcohol from these sources is much too great to enable it to compete with other products in many fields where it could be used to great advantage. This is due not so much to the cost of manufacture as to the cost of the raw material from which the fermentable sugar is obtained. The most economical source of starch on this continent is Indian corn, yet this raw material costs at present $21.60 per ton. One ton of corn gives about 90 gallons of alcohol of 94 per cent at a cost of 24 cents per gallon for raw material. About two gallons of raw molasses produce 1 gallon of 94 per cent alcohol and this raw material costs 21–22 cents. The raw material of German alcohol has been estimated to cost 20 to 21 cents per gallon of alcohol of this strength.

There is a process in which a waste product of nominal commercial value is the raw material from which fermentable sugar can be obtained. The actual cost of sawdust and other wood waste to any industry is difficult to estimate. In some localities where the quantity of waste is not great a local market for it has been established and in most forms it has been disposed of at a small profit. The larger mills now that electricity is of such general application have in many cases increased their power and find an economic outlet for all forms of wood waste as fuel for generating this power. There remains, however, the great majority of the large sawmills of this continent where the wood waste has either to be disposed of by sawdust burners at a cost of about 20 cents per ton or allowed to accumulate in heaps upon the land or is turned into an adjoining stream to be a nuisance and an injury for many years if not for generations.

Any industry employing wood waste situated in the vicinity of a large mill of the last-mentioned class should be able to obtain waste for the cost of transportation and handling which under moderately favorable conditions should not exceed 30—40 cents per ton.†

As I shall later explain, one ton of sawdust or other comminuted wood waste calculated to a dry basis can be made to yield about 20 gallons of alcohol of 94 per cent. This then reduces the cost of raw material from 20–24 cents to 2 or 2½ cents per gallon of alcohol.

That fermentable sugar can be produced from wood has been known to chemists for nearly a century. Braconnet as early as 1819 by heating wood cellulose with sulphuric acid produced a pulp which contained glucose. The sulphuric acid, however, could not be economically removed. Since then no process has been devised until quite recently for hydrolyzing cellulose and allied bodies economically.

Numerous attempts have been made to solve this problem and the list of patents on the subject is a large one. Prior to 1900, when the Classen patents were taken out, the hydrolyzing effect of many acids on starch and the celluloses had been studied and the process patented. C. Pope, for instance, in 1898 obtained a patent for hydrolyzing starch and obtaining fermentable sugar by sulphuric acid, and Einar Simonsen in 1898 a patent to make sugar glucose from sawdust by the action of dilute sulphuric acid. Sulphurous acid had long been used to make wood pulp from comminuted wood before these patents. It was also well known that when sulphurous acid was heated with wood sulphuric acid was always formed which took part in the reaction, and its action was prevented in pulp making by the use of calcium bisulphite, the sulphuric acid combining with the calcium as it was produced.

Dr. Alexander Classen of the Polytechnic School of Aachen stated in 1900 that sulphurous acid in aqueous solution under pressure converted the cellulose of wood into glucose and that the product could be fermented in the usual way yielding ethyl alcohol. He patented this process all over the world, but the original methods as stated in the patent proved to be crude and unworkable. The claim is as follows:

The process of converting cellulose into sugar which consists in heating the cellulose in a closed vessel at a temperature of 120 deg.—145 deg. C. with a solution of sulphurous and sulphuric acids substantially as described.

After successful experiments in a test plant erected by Classen in Aachen a similar plant on a larger scale was erected at Highland Park near Chicago to demonstrate to American capitalists its possibilities. The results were so satisfactory that a larger plant on a commercial scale was erected at Hattiesburg, Miss. The plant included the following elements:

1. An acid apparatus where the solution of sulphurous acid was prepared and where the excess of sulphur dioxide after use could be reabsorbed and saved for further utilization.
2. A revolving cylinder 30 feet long and about 40 inches in diameter which formed the converter or digester.
3. An exhausting battery consisting of a series of tanks in which the sugar was washed from the partly converted sawdust by hot water.
4. Neutralizing vats in which the various acids remaining in the saccharine liquid were neutralized by calcium carbonate.
5. Fermentation vats and a still where the process was completed as in an ordinary distillery.

The wood waste was introduced into the digester (which it nearly but not completely filled) made of iron lined with lead to prevent action of the sulphuric acid, and surrounded by a steam jacket by which it was heated. This revolving cylinder had a capacity of about two tons. To the charge of wood waste was added a weight of a nearly saturated solution of sulphur dioxide corresponding to about one-third of the raw material. The drum was closed air-tight and steam turned into the jacket while the whole slowly revolved. The temperature of the interior was thus slowly raised to 290 deg.—300 deg. F. and the pressure to about one hundred pounds. After from four to six hours the sulphurous acid and steam were blown off into the absorbing tanks and the sulphur dioxide thus partially recovered. The cover was removed and the contents emptied, looking then very like finely ground coffee. This finely divided treated wood was conveyed to the exhaustion batteries and the sugar extracted. The liquid obtained contained from 350—400 pounds of sugar for each ton of raw material treated. The next steps were to neutralize the acid liquid, allow it to clear by subsidence, pump it into the fermentation vats, ferment it by yeast and distill the product in the usual way. It was claimed for the process that each ton of wood waste gave about 18—20 gallons of absolute alcohol.

The history of the original Classen process is an excellent example of how a process which will give very good results on a laboratory scale will just fail to succeed when magnified to a size necessary for working on a commercial basis. Even the strongest supporters of the original Classen process do not now believe it to be a success as a money-making proposition.

The difficulties in the way to sucess for this process are explained to be: (1) The length of time necessary to convert 1½ to 2 tons of wood, this requiring from four to six hours; (2) the quantity of acid required; (3) the prolonged action of so much acid and water in the rotating converter reduced the wood to a very fine powder and formed much sulphuric acid which, acting on the sugar and other substances, produced gums and caramels, and so made the complete extraction of the sugar from the residue very tedious and expensive. (4) The buckling and breaking of the lead lining of the converter which had to be repaired after every two or three operations and proved a very great source of delay and expense.

The plant built in the United States, which is reported to have cost for building and working for a year about $250,000, has not been used for some time. Two chemical engineers, Malcolm F. Ewen and G. H. Tomlinson, who were associated with the Classen process, both in Germany and the United States, finding the original process unlikely to prove a commercial success obtained substantial financial aid from a Chicago engineer, Mr. J. M. Ewen, and in 1904 began experimenting along new lines to overcome the difficulties which prevented the old process from being a success. The result of their researches and experiments has been to shorten the time of the hydrolysis in the converter from six hours to 40 or 45 minutes, to obtain the treated wood waste in a form which could be quickly and efficiently extracted, to devise a converter which is not in the least degree affected by the process, to reduce the quantity of acid employed, and to obtain a very uniform and large yield of fermentable sugar from wood waste.

This process, by the courtesy of the patentees, I was enabled to study in June, 1909, at Chicago Heights, about 20 miles from the city of Chicago. The plant was erected by the Wood Waste Products Company, now called the Standard Alcohol Company, which has control of the Ewen-Tomlinson patents. This experimental plant was composed of units of commercial capacity and was set up in workshops in the grounds of a large machinery manufactory. It consisted of the same elements as those required for the older process, viz.: the acid generating and recovery apparatus, a converter or digester, a battery of diffusion cells to extract the sugar, neutralizing and storage tanks, fermentation vats and a distillery.

The converter in use at Chicago was a revolving cylinder 12 feet by 8, of steel, lined with fire-brick and set in cement of lead oxide and glycerin. It had a capacity of about two tons of shavings or three of sawdust. The wood waste, sawdust, shavings or small chips, are dumped into the converter, which is completely filled, and is then closed air-tight. Gaseous sulphur dioxide in measured quantity, only about 1 per cent by weight of the dry wood, is introduced through a perforated tube passing through the trunnions of the cylinder and thus through the center of the revolving mass of the sawdust. When the required quantity has been added the sulphur dioxide is turned off and live steam is introduced through the same tube till a pressure of about 100 pounds is reached. It takes from 10 to 15 minutes to get the contents of the digester heated up to the required temperature. The steam is then cut off and the digester revolves slowly for another 40 to 45 minutes, the temperature and pressure being kept constant, when the hydrolysis is complete. The steam carrying with it the terpenes, the excess of sulphur dioxide and some acetic acid, is then discharged into the absorption tank. The manhole is again opened and the coffee-colored chips and sawdust discharged into a V-shaped bin which supplies the conveyors going to the diffusion cells.

In the plant now being built for the Du Pont Powder Company at Georgetown, S. C., it is probable that there will be three or four converters, egg-shaped or spherical, and capable of taking four to five tons at one charge. These are to be so arranged that when the digestion in one is completed the steam and acid may be directly discharged into a second digester already filled with wood waste, thus saving time and expense in recovering the acid of each charge.

From the converter the treated wood is conveyed to the extraction battery, where it is rapidly and effectively exhausted by hot water, the acid liquid neutralized with slaked lime and carbonate, allowed to settle in the settling tank, and then pumped to the distillery, fermented and distilled.

In the tests that I made of the plant two charges of the converter were used. The first contained 3,623 pounds of shavings from Chicago mills, air dry and almost entirely pine. This carried 18.61 per cent of moisture, making the dry wood equivalent to 2,948.8 pounds. The second charge consisted of 2,992 pounds of shavings and 2,105 pounds of wet hardwood sawdust, consisting chiefly of oak, but with some pine. The total weight of the second charge was 5,097 pounds, with a dry wood equivalent to 3,058 pounds. This second charge was made with a view of testing the effect of the process on sawdust carrying a very high percentage of moisture. The sawdust gave on analysis 70.4 per cent moisture.

The product of the action of steam and sulphur dioxide on the first charge of shavings was a friable brown product resembling tan bark or coffee, with a fragrant aromatic odor and strongly acid. Analysis of this gave

	Per cent.
Moisture	33.23
Total reducing sugars	13.70
Calculated to dry basis	20.20
Total acidity (as sulphuric acid, SO_3)	1.23
Sulphuric acid (SO_3)	0.418
Reducing sugars, fermented	10.78
Unfermented sugars, xylose, etc.	2.09

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* Read before the Society of Chemical Industry and published in its journal.

† Tenders have been offered to deliver two hundred yards away 200 tons of sawdust, etc., per day at twenty-five cents per ton.

The wood waste in the second charge after treatment resembled the heated shavings but was finer and had a powerful aromatic odor and gave the following results

	Per cent
Moisture	34 63
Total reducing sugars	14 28
Calculated to dry basis	24 18
Total acidity	1 12
Sulphuric acid	0 353
Reducing sugars, fermented	10 97
Non fermented matter xylose etc	3 21

The total weight of waste wood in the form of saw dust and shavings in these two charges was 8 760 pounds or calculated to a dry basis 6 007 1 pounds

The treated wood was then exhausted with hot water in the extraction battery The liquid containing the sugar from these two charges was collected in one storage tank and occupied a volume of 2 984 gallons or 26 150 pounds in weight The mingled liquors contained 5 6 per cent of reducing sugars calculated to dextrose

The total acidity was 0 64 per cent calculated to sulphuric acid Of this 0 [illegible]1 per cent was sulphuric acid and the balance was composed of acetic acid a little sulphurous acid and aromatic compounds of the type of pyrogallol The presence of the polyphenols and tannin bodies was most obvious On neutralizing this solution with lime and calcium carbonate it blackened rapidly and when ready for fermentation had an inky color due to the oxidation of the aromatic salts The liquid also contained a considerable amount of furfurol As there is little or no nitrogenous material suitable for yeast food in the liquor it does not ferment well alone hence before adding the yeast about half a bushel of malt sprouts was added to a vat of [illegible]000 gallons as food for the yeast

In this experimental plant various forms of yeast have been tried The problem as to which particular breed of yeast will give the best results was in June last still unsolved The yeast used in my experiment was brewers yeast from a neighboring lager beer brewery which was found to give constant and regular fermentations but not more than 7[illegible] or 80 per cent of the theoretical yield of alcohol was obtained The fermentation occupied about three days when the liquid was handed over to the gager and distiller who was an employee of the United States Government and placed in charge of the distillery From the 2 984 gallons of fermented fluid corresponding to 6 007 1 pounds of dry wood the gager reported 115 92 gallons of proof spirit or [illegible]1 06 gallons of 9[illegible] per cent alcohol

This will be seen to be equivalent to 20 [illegible]5 gallons per ton of wood waste calculated to a dry basis or 14 1[illegible] gallons per ton of wood waste including the wet sawdust which contained over 70 per cent of moisture This alcohol when rectified to 94 per cent is of a potable spirit crystal white and carries no trace of odor or flavor of wood It contains no trace of methyl alcohol or of the higher alcohols such as fusel oil but gives the reaction for traces of furfurol and aldehyde

At present there has been little or nothing done toward utilizing or indeed determining the quantity and value of the by products resulting from the manufacture of ethyl alcohol by this process The Standard Alcohol Company has contented itself with manufacturing a very cheap and pure ethyl alcohol and has left the working out of the by products to the future

The wood waste left behind after complete extraction is a friable cellulose and represents about 65 per cent of the original wood of which only about one third is rendered soluble and extracted by the process This material according to the present plan is to be squeezed between rollers dried partly by waste heat from the boilers and used as fuel Turpentine and acetic acid are found in the absorption tanks after blowing in the steam from the converter and will no doubt be recovered

In France there is in operation another process for the manufacture of ethyl alcohol from wood waste I know nothing of this process beyond an account of it which appeared in the General Electric Review of September 1909 by G U Borde The claims for this process are interesting and extraordinary Finding the Classen process unworkable on a commercial scale the company that controlled those patents for France is reported to have so modified the process as to largely increase the value of the by products, chiefly the acetic acid and the solid tailings and can still produce about 20 gallons of alcohol per ton The raw material is treated in a Classen converter with a solution of sulphurous acid at a pressure of 100 pounds Neither the time required—a most important item—nor the form of the converter, nor yet the quantity of acid used, are stated in the report From the profound change effected in the character of the wood, however, the process must be greatly prolonged and the sulphuric acid formed given ample opportunity to attack the cellulose. The digested mass is allowed to partly cool in the digester when it is found to have shrunken about 25 per cent. The sulphurous acid is recovered and the material from the digester passed over to a separator in which the acetic acid is recovered by vaporizing it with steam The whole mass without any attempt at separating the sugar is then neutralized made into a mash which is fermented and distilled in the same way as an ordinary grain mash is handled in a whisky distillery

The tailings from the still are compressed and dried as in the previous process by waste gases from the boilers This material is claimed to be useful as a stock food or can be briquetted or mixed with magnesia to form artificial stone of value In an experiment conducted by the writer I am quoting he obtained from 3 200 pounds of refuse wood 211½ gallons of 94 per cent alcohol 76 pounds of acetic acid and 1 800 pounds of stock food The value of this he estimates as follows

Alcohol at 40 cents per gallon	$8 [illegible]
Acetic acid at [illegible] cents per pound	[illegible]
Stock food at $[illegible] per ton	17 [illegible]
	$[illegible]0 41
Estimated cost of production	$7 00
Net profit	23 41
	$30 41

If this be a true estimate of the value of the products obtained from a ton and a half of sawdust it is much more profitable than the process I have reported upon The ethyl alcohol produced according to the above is of secondary importance both commercially and economically to the manufacture from sawdust of a foodstuff for stock of greater value than Indian corn The description of the process does not convince one that the inherent difficulties of the Classen process have been removed The exaggerated value placed upon the stock food is obvious There is no reason however why a prolonged digestion of wood at a high temperature should not greatly increase the yield of acetic acid and might produce a substance from cellulose by the hydrolyzing effect of sulphuric acid which might have a food value but necessarily a very low one after the extraction of the sugar It is known that the partial hydrolysis of keratin (horn hoof hair etc) renders such substances digestible If the process be carried so far as this however it seems very probable that the sulphuric acid formed would destroy much of the sugar and thus lower greatly the yield of alcohol In the Ewen Tomlinson process which I have studied it was found that the more rapidly the contents of the digester could be raised to the required temperature the shorter was the time required to produce the maximum yield of sugar A gradual elevation of temperature as occurs in the Classen process induces secondary reactions and a lower yield of fermentable sugar This rapid heating of the contents of the converter is only possible by the Ewen Tomlinson method of introducing live steam into the interior of the mass by the perforated tube in the axis of the converter

All will watch with interest the development of these two offsprings of the Classen process in America A plant is being erected to use this French process at Hadlock Wash and another is proposed for some place in Ontario

As to the cost of production of ethyl alcohol by the Ewen Tomlinson process a very close estimate has been made based upon tenders and the experience of the patentees in the Classen plant Broadly speaking the cost is about the same as that required to produce alcohol from grain or any other starchy material Outside the converter itself there is nothing used in the plant which is not quoted on the market and made for other purposes Without going into details a plant capable of handling 100 tons of dry sawdust in a ten hour day or working continuously 200 tons per day including buildings of a simple character and of cheap substantial construction was estimated at $99 [illegible]00 The daily cost of maintenance including interest depreciation labor and material allowing 50 cents per ton for the sawdust or other wood waste would amount to $217 i e $217 for 100 tons or $2 17 for 20 gallons of alcohol 90 per cent or a net cost of 10 8 cents per gallon No allowance is here made for fuel save the cost of drying the unused portion of the saw dust This estimate further is made on a plant not smaller than 100 tons

When one considers the possible value of the by products from a large plant and the fact that quite 20 per cent of the available sugar was not fermented in the experiments made last June it would appear that cheap industrial alcohol has at last arrived* Ethyl alcohol from grain 94 per cent averages about 52 cents to the consumer without the government tax and denatured alcohol from 45 to 60 cents Alcohol made from refuse wood should not cost the consumer more than 20 to 25 cents

Quite apart from its economic aspect the manufacture of fermentable sugar from wood by this process is intensely interesting to the chemist The process is essentially one of hydrolysis analogous to the conversion of starch to sugar by the amylolytic ferments The celluloses are like starch polysaccharides of unknown constitution They are generally represented as having the same percentage composition and empirical formulae and just as we can represent the hydrolysis of starch to maltose and dextrose so we can show how by the assimilation of water the cellulose can give rise to maltose and dextrose It is assumed that it is the cellulose element in the wood which gives rise to the sugar

I was much struck by the regular action of sulphurous acid upon the sawdust a constant quantity about 3[illegible] to 40 per cent of the wood only being attacked We know from the studies of numerous chemists such as Hug Muller Sachs Cross and Bevan and others that wood freed from adventitious constituents such as the tannins coloring matters resins etc is strikingly uniform in the composition of its fundamental tissues notwithstanding the great variety in structural complexity and this uniformity in composition is not confined to species but is found to extend to all sorts and varieties of woody tissue The average composition of wood from all sources may be said to be water 11 per cent cellulose [illegible]0 per cent soluble in water [illegible] per cent non cellulose [illegible] per cent Lignum vitae and ebony are exceptions being very low in cellulose and high in non cellulose

In the Classen patents and in one of the Ewen Tomlinson patents it is the cellulose which is claimed to be converted into fermentable sugars It seems more than a coincidence that the quantity of material hydrolyzed in the Ewen Tomlinson process should be so constant and should correspond so closely to the proportion of non cellulose found in woods In all processes of hydrolysis the noncellulose or lignone complex is the first to break down whether the hydrolysis occurs in an acid or an alkaline medium There is every evidence that here the lignone complex is broken down The presence of hydroxy derivatives of benzene of pentoses acetic acid and furfurol in quantity is obvious in the liquid extract of the treated wood It seems probable that the lignone complex in woods is attached to a certain proportion of cellulose (hemicellulose) as well as to the oxy cellulose and perhaps to the true fiber cellulose

The material left after treatment consists of cellulose which is found on being again submitted to steam and sulphur dioxide to yield but a trace of sugar True fibrous cellulose (absorbent cotton) in another experiment remained unattacked Its physical as well as its chemical properties were practically unchanged

Under the conditions of the process a small quantity of sulphurous acid is employed for a short time only and very little sulphuric acid is formed It would seem that the acid acts here as a catalyzer inducing a rapid hydrolysis of the lignone complex and of a proportion of easily attacked cellulose The oxycellulose for the most part and the true cellulose present are not seriously altered chemically It would seem possible that authorities to the contrary notwithstanding the lignone complex is capable of yielding a certain amount of fermentable sugar Should this on further study prove to be the case it might be possible to treat pulp wood by this process as a preliminary to its conversion into pulp and then by a second treatment to produce pulp fiber from the unattacked residue

There is little doubt that in the original Classen process there was owing to the larger proportion of acid and the prolonged action a more profound action on the cellulose and the lignone complex as well as probably a secondary action on the carbohydrates produced

In a lumber producing country like Canada any industry that can utilize waste wood and give it commercial value should receive encouragement If this be the revolutionary discovery which the Department of Agriculture at Washington has pronounced it to be it will add much to the wealth of nations It will not only open up new fields for the use of industrial alcohol but will liberate for use as food the million bushels of grain now used in the manufacture of ethyl alcohol 9 per cent of which is used as a luxury in life and regarded by many as a distinct evil in the community

* * *

Nature quotes an article in the Physikalische Zeitschrift by Dr J J Kossonogow of the University of Kiev on the application of the ultramicroscope to the study of the phenomena of electrolysis He finds that when an electrolyte is examined under the ultramicroscope at the moment the current is switched on there appears in the field of view a number of bright points of light which travels toward the electrodes with velocities of the same order of magnitude as have been found for the ions The path may be deviated by means of a magnet When a point reaches an electrode it appears to attach itself and take a crystalline form None of these appearances is observed in the case of a non-electrolyte and the author considers he has proved beyond the possibility of doubt that the ultramicroscope provides a powerful means of studying directly the motions of the ions in electrolysis

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* The Standard Alcohol Company claims to be able to produce this alcohol at a cost of seven cents per gallon in a large plant Its plant has been described in the SCIENTIFIC AMERICAN

MODERN STAGE ILLUMINATION.

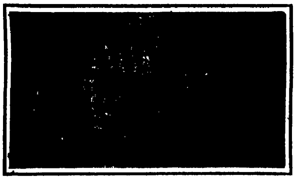
THE PASSING OF THE OLD FOOTLIGHT.

BY DR. A. NEUBURGER.

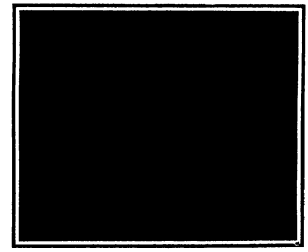
Like all other technical arts the arrangement and illumination of the theatrical stage have been greatly developed and improved within the last decade. Formerly wings were used which projected laterally into the scene together with soffits hanging down from above. Both wings and soffits were illuminated from the front and sometimes from the sides also. When the Meininger company made its celebrated tours the value of a good stage arrangement and its influence upon the effect of the drama were made evident. Since that time continual endeavors have been made to improve the stage equipment. In the first place the wings and soffits were abandoned and genuine closed rooms with ceilings were constructed; then the various objects which had previously been represented by pictures painted on canvas were constructed in plastic form, and in some of the new theaters even trees with realistic cylindrical trunks have been introduced. At the same time the illumination of the stage was improved. The electrical system was perfected and the lamps were arranged to produce a great variety of effects. A great improvement was the introduction of the so-called regulator. This is an electrical switchboard controlled by one man, who is thus enabled to light and extinguish any lamp at will, to throw a flood of red, green or white light over the stage, and to produce various effects of light and darkness. The operator of course must closely follow the action of the play and adapt the illumination to it.

STRIPS OF COLORED CANVAS FOR PRODUCING DIFFUSED LIGHT OF VARIOUS HUES

In spite of all these improvements the modern stage still fails to give a true representation of nature. The most striking difference between natural scenes and their reproduction on the stage is in the illumination. Almost everything we see in ordinary life appears in diffused sunlight. The rays of the sun are reflected not only by clouds but by the earth and various objects upon its surface, such as trees, house walls, etc. In this manner is produced an intricate mixture of reflected rays or a diffused illumination which exerts a peculiar effect upon the eye. This effect cannot be correctly reproduced by the current method of stage illumination in which numerous incandescent lamps throw their rays directly upon all objects. The difference was not so marked when painted scenery was used exclusively, but since the introduction of solid objects very unnatural effects are produced by the present system of illumination. This is particularly striking when an attempt is made to imitate the intense diffused light produced by the sun shining through clouds. The great difference between natural illumination and stage illumination was first fully appreciated by the artist Mariano Fortuny of Venice, who after a long course of experiments carried on with the assistance of the General Electric Company of Berlin, has invented a new process of stage illumination, which closely imitates the conditions of nature and presents all objects in diffused light.



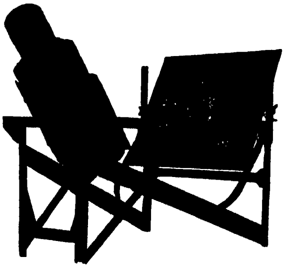
PORTABLE APPARATUS FOR DIFFUSED ILLUMINATION



FRAME OF STAGE SKY SEEN FROM BEHIND

Arc lamps are used exclusively, as their light corresponds in composition most closely with sunlight. The lamps however do not shine directly upon the stage, but their light is reflected by surfaces of cloth and is thus diffused. In order to produce the various tones observed in nature, the reflecting surfaces are composed of a number of strips, some of which serve for the production of color and others for the modification of the light by an admixture of black or white. Not every gradation of tint observed in nature can be reproduced by these means however, and therefore they are reinforced by the interposition of colored glasses between the lamp and the reflecting surfaces. This device is used in particular in producing the colors of sunset and sunrise, storms, etc. In order to obtain the closest possible imitation of nature it is necessary that the person who controls the illumination shall be able *to observe* the effects which he produces. This is not the case in the employment of the old regulator, which was placed behind the scenes. The operator could at best see only part of the stage and could not form a correct judgment of the appearance which even that part presented to the spectators in front. In the Fortuny system the apparatus is so arranged that it can be controlled from the rear of the auditorium by means of simple and inconspicuous switches. Hence the operator can follow the effect and assure himself that all is going well.

But even these devices cannot in all cases assure a correct reproduction of natural conditions. The "vault of Heaven" is not a mere poetical expression but correctly describes the appearance which the sky presents to the eye, and this vault has much to do with the illumination of objects on the earth's surface. So Fortuny introduced a vaulted sky into his system. The imitation may be rigid, collapsible or even portable. One of the accompanying illustrations shows the light frame of the vault seen from behind. The front or concave side of the frame is covered with dull white cloth, upon which the light already diffused by the colored, black and white reflecting surfaces is thrown. Hence the stage is illuminated by light which has been reflected twice, and very natural effects are produced, including aerial perspective, which cannot be obtained by the current system of illumination, in which the painted sky is as opaque and glaring as the rest of the scenery. Clouds are represented by reflecting the rays of the lamps directly upon the vault by mirrors and interposing transparencies of clouds, which may be moved, if desired, in the path of the rays. In this way the effect of motionless or fleeting clouds, delicate and fleecy or massive and opaque, can be imitated very accurately, especially as the vault of the sky behind them appears in its natural colors.



APPARATUS FOR PRODUCING CLOUD EFFECTS

After this general description of the Fortuny system we will mention a few of its most interesting technical details. One of the illustrations shows the reflecting surfaces, composed of strips of various colors, which can be moved by chains passing over rollers so as to bring any desired portion into action. This operation can be effected slowly or rapidly, as desired. Another illustration shows a portable apparatus in which the lamp is placed close in front of the canvas strips. In another picture we see the apparatus for the production of cloud effects, consisting of an arc lamp and a mirror bearing a picture of a cloud. The general effect produced by the Fortuny system of illumination is well illustrated by the picture of a stage scene photographed by means of the illumination used in the performance. When we compare this with the coarse effects, harsh contrasts

A STAGE SCENE PHOTOGRAPHED BY THE ILLUMINATION PRODUCED BY THE FORTUNY SYSTEM.

and unnatural shadows of ordinary stage scenes the superiority of the Fortuny system becomes evident Not only are the defects just mentioned eliminated but the seams in the canvas the sharp edges folds projections and other imperfections of ordinary scenery no longer remain to destroy the illusion

The method of attaching the vaulted sky to its frame is very interesting It is necessary for the canvas to present a smooth concave surface which never could be produced by nailing or similar methods The problem was solved by using two quadrantal gores of air tight canvas one of which is attached closely to the frame while the other which is turned toward the spectators hangs loosely from the top of the frame The two gores are attached together by their edges so as to form a perfectly air tight bag By means of a small air pump the air is withdrawn from this bag and the front surface of canvas is consequently pressed tightly against the other and the frame behind it without showing a fold or wrinkle The frame can be raised and lowered in sections like a phaeton top and can be raised at the back so as to leave the stage beneath it entirely clear for the setting of the scene When all is ready the frame is dropped at the back and a few seconds operation of the air pump gives the canvas the required smoothness The Fortuny system of illumination is already in experimental operation at Kroll's Opera House in Berlin where it has met with remarkable success —Fuer Alle Welt

AN AUTOMATIC STAMP VENDING MACHINE.

A NEW FRENCH DEVICE.

BY LUCIEN FOURNIER.

In France the introduction of automatic stamp vending machines was impracticable before the reduction of the rate of postage for ordinary letters to ten centimes The construction of a machine requiring for its operation the insertion of two coins of different dimensions was a problem too difficult to attract inventors especially in view of the moral certainty that such a machine would never become popular

Soon after the reduction in the rate of postage the Abel Automatic Machine Company submitted to the government several stamp vending machines which were installed in the Paris post office and have worked with perfect regularity It is to be hoped that this system will be adopted by the postal service to the great convenience of the public for the machine can be set up almost anywhere and can be arranged to accommodate a letter box under the mechanism The construction of the apparatus is sufficiently curious and interesting to merit a detailed description of its two essential organs the coin tester and the apparatus for delivering stamps

The Abel coin tester makes use of the magnetic principle which is employed in the Fodor letter registering machine (described in the SCIENTIFIC AMERICAN December 4th 1909) The members of the French Académie des Sciences who praised so highly the ingenuity of the Fodor machine appear to have been ignorant of the fact that the same principle has long been utilized in similar machines in other countries The Abel coin tester is shown in Fig 3 The coin is inserted in a vertical position into the mouth of an inclined chute *I* of rectangular cross section which is just high and wide enough to allow the ten centime piece to pass The coin rolls down the chute strikes a steel cylinder and rebounds with a force just sufficient to cause it to enter a second chute which conducts it to the cash box In its course it strikes a lever, which unlocks the mechanism for the delivery of stamps If a piece of iron or steel is substituted for the coin it is arrested in the first chute by the attraction of the magnet *AA* and is expelled from the machine by pressing a button placed beside the coin slot This button moves the lever *L* which, acting on the crank pin *D*, raises one side of the chute which is hinged at the top to the other and fixed side At the same time the frame *C* which surrounds the poles of the magnet moves outward and detaches the piece which falls into a chute that carries it out of the machine The movable side of the chute *I* is cut away to so great an extent that a non magnetic substitute of a diameter even slightly less than that of the ten centime piece falls of itself out of the chute and follows the subsequent course of the iron token A piece which is too thin becomes lodged in a groove at the bottom of the chute and is expelled by pressing the button After passing all of these tests the coin is subjected to the test of elasticity by its impact upon the steel cylinder A piece of lead of the exact dimensions of the ten centime piece for example would not rebound sufficiently to gain the chute leading to the releasing lever and the cash box while a substitute slightly more elastic than the ten-centime would rebound with sufficient force to carry it back through the entire length of the chute *T* and to expel it from the coin slot The machine now in use can be operated by foreign coins of the dimensions and composition of the French ten-centime piece although the coin, before dropping into the cash box can be inspected through the perforated plate shown at *D* (Fig 2) The manufacturers now claim to have invented a device which will reject foreign coins

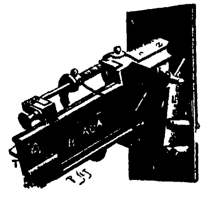


Fig 3 —PART OF THE COIN TESTER

The mechanism by which the stamps are delivered is shown in Fig 4 A strip of 500 stamps is drawn from the reel *I* by two pairs of milled wheels *M* and *N* which are connected by gearing with the driving shaft 4 The strip of stamps is pressed against the milled wheels by corresponding friction wheels carried by the hinged front *P* which is shown open in the illustration and its motion is guided by the smooth rollers *C* between the upper wheels *M* and by a smooth vertical rail on each side of the wheels The circumference of the milled wheels is greater than the length of a stamp but a sector is removed leaving an arc of the exact length of a stamp The movement of the strip is regulated by the two V shaped pieces *I O* which are pivoted at *O* The inner branches of these pieces carry pins which enter the perforations between the stamps and which bring the strip to rest with the line of perforations exactly in front of the slit *I* The rods *T* above and below this slit then advance and press the two stamps firmly against the front piece *P* and a moment later a very sharp steel blade of the exact width of the stamps emerges from the slit and cuts through the line of perforations detaching the stamp at the end of the strip The knife is driven forward very quickly by a rack and pinion and is brought back by a spring The detached stamp glides down into the receptacle *S* (Fig 1) The purchaser opens the door of this receptacle and removes the stamp

If the strip of stamps is exhausted or torn the coin tester opens and returns the coin In foreign machines the nearest post office is automatically informed by an electrical signal of the stoppage of the apparatus from this or any other cause The motive power of the Abel machine is furnished by a simple clockwork The public prefers the automatic method of purchasing stamps because it is more expeditious than the old way —La Nature

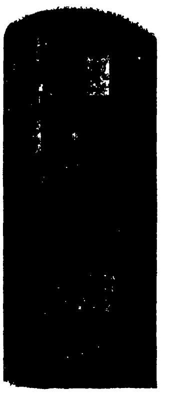


Fig 1 —THE ABEL STAMP VENDING MACHINE OPENED

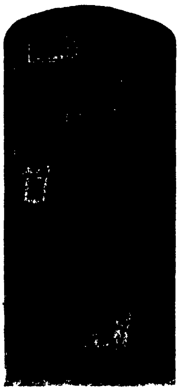


Fig 2 —THE ABEL STAMP VENDING MACHINE CLOSED

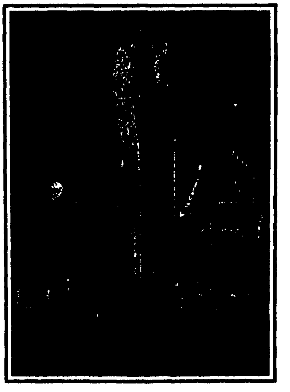


Fig 4 —THE MECHANISM FOR DELIVERING STAMPS

Britannia Metal Coating for Brass Articles (according to C Puscher) —Solution Forty five parts powdered tartar and 4 parts tartar emetic dissolved in 1 000 parts of hot water add 50 parts of hydrochloric acid 125 parts powdered tin and [illegible] parts of powdered antimony Heat all in a well glazed vessel to boiling and dip the article in after 1 to 30 minutes the coating is completed

THE DEVELOPMENT OF POWER SYSTEMS.*

A CONSIDERATION OF PRIME MOVERS.

BY CHARLES EDWARD LUCKE, PROFESSOR OF MECHANICAL ENGINEERING IN COLUMBIA UNIVERSITY

In the story of the development of machinery the part played by rods shafts cylinders and other elements of the mechanism is subordinate to the conceptions of physical processes which each arrangement of parts is devised to carry out It is more important to know just how steam should be treated in order to obtain the most work than to be able to make a steam engine that will run It is more important to know how a combustible gas mixed with air should be treated to give an explosion producing the highest possible pressure than to be capable of making a chamber strong enough to withstand the effects of the explosion Each [illegible] it is conceived adds a fact to man's understanding of nature and in turn contributes to the discovery of the next

Air and water in motion being capable of moving wheels with paddles naturally leads a student to inquire how fluids may be put in motion a question which once conceived almost instantly answers itself by allowing them to escape from high pressure chambers The next logical inquiry is how may fluids be prepared so as to be under high pressure in chambers from which they may escape This leads to the discovery that water may be boiled in closed vessels and that explosions of powder or gaseous fuels may be caused resulting in the desired high pressure or more simply water may be led in pipes from the upper level of a falls to the lower and at once the three characteristic systems of power generation are understood

An almost infinite number of combinations of mechanism parts can be found to carry out each process The processes are fundamental the mechanisms incidental It must not be assumed however that the parts may have infinite variety of form or that they may be made of any material for there are limitations which cannot be ignored The elements must have such simple form that they may be easily made by the workmen Both the form and material of each part must be suitable in strength stiffness flexibility and wearing qualities The whole machine must not be too costly to produce nor to keep in repair and it must not require too much skill on the part of the operator The problem of power machinery development is divisible into several parts

First What processes must be carried out to produce motion against resistance?

Second What combinations of simply formed parts can be made to carry out the process

These two parts when worked out will result in some kind of an engine but it may not be a good engine for it may use up too much natural energy for the work it does some part may break or wear too fast another may have a form that no workman can make or use up too much material or time in the making In short while the engine may work it may do its work at too great a cost in coal or water, in attendance or in investment There must therefore be added other elements to the problem

Third How many ways are there of making each part and which is cheapest? What other form of part might be devised that would be cheaper? What cheaper material is available which would be equally suitable?

Fourth How sensitive to care are all these parts when in operation and how much attendance and repair work will be required to keep the machine in good operating condition?

Fifth How big must the important parts or the whole machine be to utilize all the energy available or to produce the desired amount of power?

Sixth How much force must each part of the mechanism sustain and how large must it be when made of suitable material so as not to break?

Seventh How much effective work can the machine do for each unit of energy supplied?

In the early days of power generation all these elements were not recognized They were developed and studied about in the order named a fairly satisfactory solution of the first parts pointed out the existence of those that followed and the necessity of studying them The solution of a new question reacted on an older one so that new solutions of the older question appeared which could not be conceived before Systematic study of engineering problems has been receiving attention for about a century and a half but has been divided into periods as the study advanced to the higher stages For example it was not until about 1860 that the seventh element of the problem was successfully treated for those power systems depending on the heat of fuel as the source of energy Although successful and commercially valuable steam engines had been continuously produced for a hundred years no one was able to calculate exactly how much of the heat in the steam might be converted into work by a mechanism ideally perfect so that the goodness or badness of a given engine could not be judged by scientific standards but only in a comparative way One machine might produce a horse power with less coal than another but no one could state positively why which of course, is the first step in rational improvement of economy But the minimum possibilities of coal consumption for a given system could not be calculated hence the comparative value of competing systems could not be judged This sort of calculation is now an everyday thing which every engineer is capable of carrying out and is the basis of all modern designing and improvement The fact that it took over a hundred years after building useful engines to arrive at a scientific conception of the fundamental processes which were being more or less imperfectly executed in machines designed largely by rule of thumb is doubly significant of the high order of mental development necessary for it when it is realized that the first and second elements of the problem were understood to a degree sufficient to enable men to produce working models some two thousand years before

The period of systematic and scientific power development is coincident with true progress in the most basic of the several branches of natural philosophy of chemistry physics mechanics thermodynamics and the theory of elasticity of materials and there is no doubt that the steam engine which was built by mechanics before basic laws were well understood attracted the attention of philosophers who in attempting to explain what took place in it created a related body of principles by which future development was guided Those men who became familiar with natural science and also with shop methods of making machinery and who brought their knowledge to bear on the problem of the production of machinery for specified conditions combining the special knowledge of the scientist with that of the shop mechanic were the first mechanical engineers and the profession of mechanical engineering which is the term now applied to this sort of business was created out of efforts to improve power systems so as to make them more efficient and better adapted to various classes of service

Nothing is more interesting than the detailed history of power system ideas mechanism and the production of both the machinery and the power itself, studied along with the parallel development of the natural sciences But this is beyond the scope of these lectures in which no more than the merest outline can be attempted just sufficient to permit of a little understanding of modern machinery

As has been already said one of the earliest understood ideas applied to power generation is that water in motion may by striking paddles on wheels move them and itself lose some of its motion or that the energy of motion can be communicated from one body to another One of the earliest kinds of wheels was hung by its shaft which was just a log of wood over the surface of a fast moving stream at such a height as would allow the paddles to dip into the water The idea involved old as it is is one of the most modern inasmuch as it is basic to the largest modern water and steam turbines It must not be understood that the basic idea consists in the dipping of paddles into a brook this is a mere incident a convenient way of making use of the real fundamental principle that the energy of moving fluids can be imparted to wheels by bringing the fluid to rest in a suitable way

In most of the modern turbines, which is the name applied to the highly developed forms of wheels designed to rob moving fluids like steam and water of their energy of motion there are involved many other principles some of which are very old and some of recent conception One of these easy to understand, is concerned with the way in which water may conveniently be set in motion Water led from an elevated tank or pond by pipe to a lower level exerts a pressure tending to burst the pipe which is more powerful the greater the drop, and the greater the pressure is the greater the velocity of the water flowing from the nozzle Similarly, water, steam, air or any other fluid existing in a chamber under pressure, will escape from that chamber through a nozzle in a jet which will have a velocity determined by the pressure The quantity of fluid that can escape as well as the energy of the jet will depend on the size of the hole and velocity of the jet It has always been found more convenient because of the concentration of energy that results to devise means of getting the fluid under pressure and then allowing it to escape in order to give it motion instead of depending on fluids naturally in motion Jets of fluid may be allowed to play on vanes or paddles in a great variety of ways, giving different types of motors all known by the class name of impulse wheels Some have one nozzle and others many the arrangement and form of vanes vary greatly

It required many years of experiment calculation and comparison to discover just what curvature and angle should be given to vanes and nozzles to secure high efficiency for while almost any combination will run there is only one best design and the determination of that best design is the principal problem of the engineer today To such perfection has this work been carried that it is now possible to predict within 1 or 2 per cent how much of the fluid energy a turbine yet unbuilt will be capable of transforming into useful work A proper relation between the speed of the vanes that of the steam jet and the angles and curvature will allow the steam to leave with the lowest practical velocity most of its original energy of motion having been imparted to the wheel and these things can now be determined with precision When the water issues in a fast moving jet from a nozzle the nozzle is pushed backward just as a gun recoils as its projectile moves out, and this principle of reaction is used in both water and steam turbines either alone or associated with the impulse action To all wheels in which the reaction of the jet rather than the impulse of its striking the vanes exerts the driving force the class name of reaction wheels is applied

The antiquity of the reaction and impulse principles is shown by the records in which it is said that one Hero 200 years B C made a steam reaction turbine in which a fantastic water vessel was heated by a fire making steam which flowing up two vertical standards hollow like pipes entered a ball arranged to rotate on the ends of the standards From the ball the steam escaped by nozzles tangentially causing the ball to spin to the mystification of the mass of the people who believed that some spirit from the other world had been brought under command A later but nevertheless old device dating from 1629 and credited to Branca an Italian, is a pure impulse steam turbine coupled by tooth gearing to a shaft with lumps on it arranged to lift pestles for crushing corn or ore

The simplest oldest and at once the most modern ideas for power generation are then

First A moving fluid properly directed may move wheels against resistance when it strikes vanes suitably formed and arranged

Second A fluid under pressure may acquire motion simply by escaping.

Third Jets of fluid escaping from nozzles or suitably formed passages in wheels may by the reaction of escape alone turn those wheels

To these principles, minute and painstaking investigation guided by progress which no doubt assisted in stimulating as well, in mathematics, mechanics physics and chemistry there has been added a vast body of engineering principles by means of which true design can be carried out, and turbines built of predicted efficiency and of proper strength in all parts

It is a most significant fact that although Hero produced a rotative steam engine, that worked, in 200 B C nearly two thousand years elapsed before the first commercial rotative steam engine was produced by Watt about 1780, and that after him the progress of about seventy years in power-steam development resulted in advances which entirely eclipsed all the progress made since Hero's time There are good reasons for this, and the key is to be found, first, in the lack of demand, and second, in the lack of information to enable makers of machinery to meet the demand when it came. Practically all the power machinery produced before the time of Watt in 1780, except special devices adapted to pump water only, was more the result of accident than of logical reasoning from desired results to means by which they might be attained Even after Watt, much that was done was prompted by a desire to do something different, a groping after something by trying everything. There was no conviction based on proof or established principles that the means were right or best. This is pure invention without which, it is true little progress is possible A conception that the new thing must produce the desired result in a truly better way or produce a new result superior to the old with no more wasteful means becomes possible only when there is available a body of facts and principles related to each other and so constituting a science by means of which existing machinery can be analyzed to reveal all faults and their causes and the performance of new machinery yet unbuilt can be predicted[*] with reasonable certainty This is true design without which invention alone may result in nothing more than interesting toys But when combined with invention design gives the engineer command over nature The basis of engineering design is knowledge of facts and principles so it is easy to understand why in the early days of engine building no true design was possible for the machine and its operation themselves supply the means for collecting the necessary facts and mental capacity however well trained can not find the relation between the facts until the facts themselves are found by tests of the machinery Once discovered and classified these relations constitute a body of principles having the force and dignity of laws of nature the discoveries and application of which to the uses of men constitute the profession of engineering

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* Abstract of second Hewitt lecture delivered at Cooper Union, New York city

FAST AND FUGITIVE DYES.

SOMETHING ABOUT THEIR CHEMISTRY.

BY PROF. OTTO N. WITT.

In order to make a thorough and methodical investigation of the behavior of colored substances i e substances which exert a selective absorption upon light we must first ascertain how those bodies act which do not exert an appreciably selective action upon the various rays of white light Such bodies may absorb all the light which falls upon them in which case we call them black, or reflect it all in which case they are white or allow it all to pass through them in which case they are transparent None of the classes thus defined is represented exactly by any earthly substance Bodies which absorb part of the incident light and reflect or transmit the remainder present the various shades of gray but are commonly regarded as gray only when a rather large proportion of the incident light is absorbed Many substances which are really gray according to the definition given above are regarded as white and almost all of the objects which we call black are really gray Absolute blackness in the strict sense of the word can be produced only by viewing the so called black bodies in the faintest possible light, as for instance when we look through a small hole into the interior of a box lined with black velvet If we place beside this hole an ordinary black body we see how far it is from being black in reality The eye is very sensitive to differences in quality but for quantitative measurement it is a very unreliable instrument Its estimation of the intensity of light depends chiefly upon contrast and when the contrast is great, none of our organs of sense is more easily deceived than the eye Upon this fact depend many remarkable phenomena and many artistic effects

We live therefore in a gray world although this gray is diversified and beautified by many colors for tinted objects are much more common than pure gray or black and white objects Let us see what becomes of the light absorbed by these gray objects Light as a form of energy is so nearly related to heat that all the laws of heat apply also to light Hence there can be no doubt that any body can be charged with light as well as with heat The quantity of heat absorbed by the body can be measured and thus is obtained the idea of heat capacity, or specific heat For the measurement of the energy of the light absorbed by bodies, on the other hand no method has yet been devised Hence the conception of specific light or light capacity has not been formed but that the light which is absorbed by a body remains in a sense attached to it is a necessary conclusion from the fact that the absorbed light can be extracted from the body, not necessarily as light but as energy in some form

The simplest case is that in which the light which has apparently been destroyed by absorption subsequently reappears as light This occurs with numerous substances which are known as phosphorescent, especially with the sulphides of calcium, barium, strontium, zinc and some other metals which after exposure to bright sunlight or electric light retain the energy which they have absorbed and give it out again as a steady luminous glow during many hours The phosphorescent light which they emit is not always white It is usually colored, and this fact indicates that the white light which has been absorbed is not emitted again entirely but only in part, rays of certain wave length having been retained and converted into some other form of energy

Phosphorescence, however is an exceptional phenomenon. Most of the substances that absorb light, and consequently all of those substances which we call black or gray, never emit the absorbed light again as light. What, then, becomes of the absorbed light? Every person can easily give the answer to this question; in fact he does give it daily by his unconscious actions In the bright sunlight of summer, on tropical journeys, in active exercise in the open air, we put on white or light-colored garments, which reflect light but in the gloomy winter we wear dark colored clothing which absorbs light Why do we do this? Because the light absorbed by our clothing is converted into heat and felt as such We make tents and parasols of white fabrics which reflect the sunlight instead of absorbing it and converting it into heat Indians and Eskimos however use dark colored tents for the very reason that they are warmer In Norway Sweden and Russia houses are painted in dark colors so that they are kept warmer by the absorbed sunlight but in southern countries houses are painted white in order to make them as cool as possible This is the most general action which bodies exert upon the light which they absorb they convert it into heat which they give out by radiation and conduction The energy is not lost but its wave length is changed It is degraded as the energy of an alternating electric current is degraded in a step down transformer An electrical transformer consists of an iron core surrounded by two coils of wire When an alternating current is passed through one of these coils a great part of the energy of the current is absorbed and is reproduced in the form of an alternating current which is induced in the other coil According to the length and diameter of the wire in the two coils the electromotive force or voltage of the induced current may be equal to or greater or less than that of the primary current A body that absorbs light acts like a transformer it absorbs the primary current of light consisting of energy of certain wave lengths and it emits induced energy of different wave lengths If the wave length of the emitted light is greater than that of the light absorbed the energy produced by induction consists of radiant heat If the wave lengths of the absorbed and emitted energies are nearly equal the body emits light in addition to heat and is called phosphorescent A third case is conceivable in which the wave length of the energy absorbed is shortened as in a step up transformer

Let us now return to the colored bodies which exert a selective absorption upon light It is obvious that this selective absorption is only a special case of the phenomenon described above but because we are here dealing with luminous energy of perfectly definite wave lengths we can follow the process of transformation much more accurately and in particular we can learn something of the hypothetical third case just mentioned The commonest case is that in which the light which is selectively absorbed undergoes an increase in wave length or is stepped down and is converted into dark radiant heat As this heat can escape freely and continuously the process can continue indefinitely The active body the dyestuff acts only as a transformer without undergoing any change in itself This is the characteristic of permanent dyes

But the transformation is not necessarily carried so far Some substances absorb only the rays of shortest wave length the green blue violet and ultra violet rays The wave length of the energy thus absorbed is increased, and the energy is emitted in the form of light of somewhat greater wave length Substances which act in this way are called fluorescent

The class of dyestuffs however, includes in all probability, substances which modify the absorbed luminous energy in the opposite direction converting it into rays of shorter wave length which manifest their presence by their chemical effects I grant that this case offers the greatest difficulties in regard to quantitative investigation, for we know little or nothing of the nature and magnitude of the other waves which are capable of being transferred to matter and of producing intramolecular chemical changes, but the energetic chemical action which we commonly observe in connection with blue, violet and ultra-violet waves suggests the inference that matter is affected only by vibrations of very short period It seems also very probable that those dyestuffs which possess the power of causing chemical changes with the aid of the light which they absorb first diminish the wave length of that light There is something fascinating in the idea of explaining in this manner the great chemical transformations wrought by chlorophyl the green coloring matter of plants which absorbs only the red or long waves of the sunlight which falls upon it and employs the absorbed energy in the production of starch from carbon dioxide

There is furthermore a practical example to support the assumption of the possibility of such step up transformation This example is the well known effect of the so called color sensitizers upon the haloid salts of silver especially silver bromide This compound when pure absorbs only the blue violet and ultra violet rays of the spectrum and is affected photographically i e chemically by them alone but if it is mixed with one of the dyestuffs which act as sensitizers it becomes sensitive to the action of the rays which are absorbed by this dyestuff The dye erythrosin for example produces sensitiveness to green and yellow green I do not know how this phenomenon could be explained more easily and naturally than by saying that the erythrosin converts the green light which is absorbed into rays of shorter wave length probably ultra violet rays which are able to affect the silver bromide This peculiar action of erythrosin is by no means dependent upon its association with silver bromide but is manifested also in other circumstances the investigation of which would occupy too much space

This example of erythrosin leads us naturally back to the consideration of fugitive dyestuffs These are simply dyes which employ in chemical work the energy which they absorb The effect in some cases is transmitted to other substances which are associated with the dyes as in the case of chlorophyl but when these substances are not present to act as anvils for the hammer of the induced energy the dyestuff itself becomes the anvil and is shattered by the waves which it emits

An important support to the hypothesis concerning the mutual actions of light and dyestuffs which is here developed is given by a property which is characteristic of all fugitive dyes for these dyes are not fugitive under all conditions Every dyer knows that some dyes produce fast colors on some fabrics and fibers and not on others and that the permanence of other dyes is largely dependent upon the nature of the mordant which is employed to fix the color in the fiber Some mordants the so called oil mordants for example when used alone destroy the permanence of otherwise fast dyes and hence can be used only in connection with other mordants Furthermore the colors produced by fugitive dyes can be made permanent by impregnating the dyed fabrics with salts of copper or other substances upon which the chemical action of the dye can be exerted so that the dye itself is protected from this action In the Middle Ages the Guild of Dyers was divided into two sections the good dyers and the poor dyers We see from the above considerations that a dyer belongs, to one or the other of these divisions according to his understanding of the peculiarities of his dyestuffs which are not unconditionally considered either fast or fugitive

I am fully aware that in this and the preceding article I have made many assertions which are not to be found in the textbooks and which consequently will give rise to head shakings contradictions and calls to order But all this does not trouble me I had the same experience in 187[illegible] when I published my views regarding the connection between the chemical constitution and the properties of dyestuffs and in 1888 when I announced my theory of the process of dyeing Both of these theories have since been accepted and have become the bases of further advances in knowledge —Translated for the Scientific American Supplement from Prometheus.

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[*] This article should be read in connection with Prof, Witt's article in the last number of the Supplement.

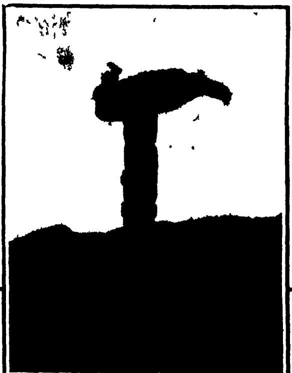
WOODEN MONUMENTS OF THE NORTHWEST COAST INDIANS.*

CURIOUS TOTEMS AND THEIR MEANING.

BY HARLAN I. SMITH.

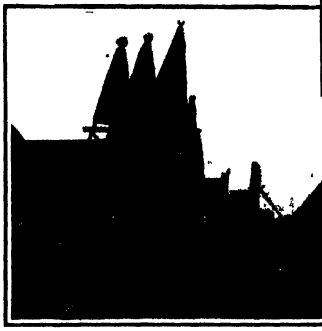
On an expedition along the northwest coast of America between Seattle and Skagway Mr Harlan I Smith of the Department of Anthropology of the American Museum New York was able to resume during the past summer the archaeological reconnoissance which he began on the Jesup North Pacific Expeditions of 1897 1899 and continued on that of the American Museum in 1903 He carried this reconnoissance onward from the northern end of Vancouver Island where work stopped on the previous expeditions to Klukwan Alaska some twenty five miles above Haines on the Chilkat River obtaining the photographs and many data regarding the ethnology of the region and securing specimens not already represented in the Museum collections He was accompanied by Mr Will S Taylor mural artist who made color sketches of the Indians and their natural and artificial environments These sketches together with the photographs and the actual ancient costumes and other specimens available in the Museum will form the basis upon which Mr Taylor will build up mural decorations for the Hall of Northwest Coast Ethnology to illustrate the home country characteristic occupations and social customs of the seven great groups of northwest coast natives

MORTUARY COLUMN WRANGEL ALASKA THE BODIES ARE WITHIN TWO COVERED NICHES IN THE SHAFT



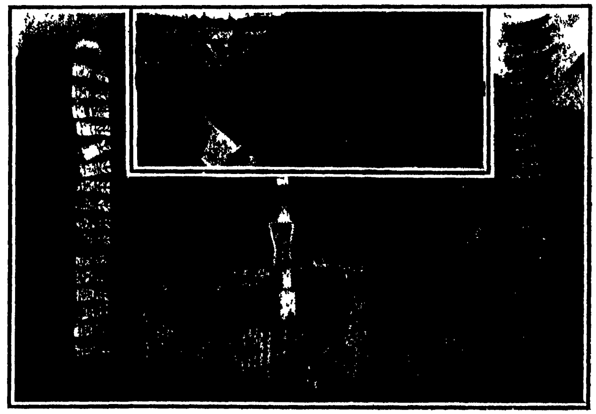
The scientific results of the trip are interesting because the archaeology of the entire coast north of Vancouver Island as far as Mount McKinley has been unknown to the scientific world In the Bella Coola valley about midway along the British Columbia coast Smith saw chipped implements marking the farthest north of the art of chipping stone in British Columbia Evidences were also found here of the relation of the early people to those of the interior Although the Indians have given up much of their old life he still found many purely native manufactures among them Pictures bruised on the rocks by some of the ancient Indians were seen near Wrangel The first stop of any length was at Victoria a town perhaps more typically English than any other in North America The Indians here have been little disturbed so that even near the city both the southern Salish and the Nootka groups may be studied Among the interesting photographs and sketches made here were one of an Indian making a dugout canoe from a cedar tree and one of a Nootka man carving a totem pole

From Victoria the expedition went by steamer to a small island near the northern end of Vancouver Isl-



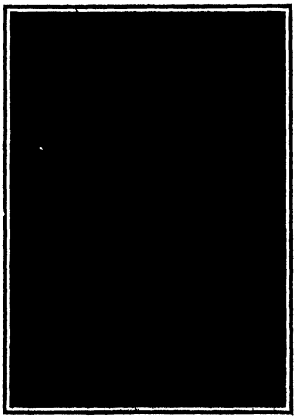
PAGAN VILLAGE BELLA COOLA DESERTED THE INHABITANTS BEING AWAY AT THE SALMON CANNERIES

CHILCAT BLANKET (UNFINISHED) AND PATTERN BOARD, KLUCKWAN, ALASKA



CHINOOK CANOE, NEAR VICTORIA THE INDIAN IS DIGGING OUT THE INTERIOR WITH AN ADZE.

NATIVE CEMETERY BELLA COOLA WOODEN REPRESENTATIONS OF "COPPERS" AND CANOES INDICATIVE OF WEALTH AND HOSPITALITY OF THE DECEASED



TREE-TOP BURIAL, SHOWING INDIAN GRAVES IN TREES, ALERT BAY.

WOODEN MONUMENTS OF THE NORTHWEST COAST INDIANS.

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* Abstracted from articles in the American Museum Journal February 1910 1 A Visit to the Indian Tribes of the Northwest Coast by Harlan I Smith 2 Results of an Art Trip to the Northwest Coast by Will S. Taylor.

and where at Alert Bay there is a tribe of the Kwakitul In spite of the influence of several other races living and working in their midst the Indians of Alert Bay in many ways keep to their old methods of living For instance although there has been a missionary here for a long time he has not been able to stop burial in tree tops as shown in the tree grave illustration The Indians must have practised this custom very recently, as some of the bodies were doubled up in common cheap trunks which can be bought only in the white man s store and are of a sort not made till a few years since In the older graves the bodies were placed in boxes made of three pieces of wood split from red cedar One of the pieces served as the bottom another as the top and the third was notched and bent around to form the ends and sides of the box Where the edges of the boards met they were sewed together with spruce roots Sometimes the boxes were painted and occasionally both painted and carved with the characteristic animal pictures of the region

Some of the Indians bury their dead in the Christian cemetery but even then show remnants of old customs Near one of the graves a fine bureau stood in the wind and rain Perhaps it had been owned and highly regarded by the woman interred or had been something that she had longed for, and now that she was dead her relatives were showing the greatness of their grief by sacrificing a valuable piece of property to the elements The Indians often erect beside the graves curious monuments such as wooden representations of 'coppers as shown in the engraving These coppers are pieces of metal of distinctive shape and markings They are of no great intrinsic value but when bought and sold among the Indians they increase to almost fabulous worth When a copper is transferred there is always a gathering and a feast The Indians value a copper so highly that the white storekeeper takes the piece of metal as credit and advances groceries and drygoods to the Indians for perhaps a whole year until they are able to go to the cannery and earn money On coming back from the canneries the Indians always redeem their copper securities and again use them buying and selling them at enhanced values and with special ceremonials

From Alert Bay the expedition moved northward to Rivers Inlet where lives another tribe of the Kwakitul Indians and there a photograph was secured of a perfect specimen of totem pole, reproduced herewith

The expedition next went to Bella Coola at the extreme eastern end of Burke Channel, about sixty miles inland beyond the usual course of steamers There is an Indian village on each side of the river The one to the north consists of Christianized Indians who have settled here leaving the pagan Indians on the south side The houses in the Christianized village are similar to those of the white people of the vicinity Near the pagan village, seen in the engraving dwell Mr John Clayton and his family He is the venerable Hudson s Bay man who keeps the store and is one of the richest and best known men living on the coast of British Columbia north of Vancouver In the Christianized village are the church and the home of the missionary, the Rev W H Gibson Both Mr Gibson and Mr Clayton were instrumental in assisting the scientists to secure totem poles for the Museum

The river at this place is fed from the snow peaks farther to the east and is icy cold It is very swift and navigated only by long canoes dug out of single tree trunks These canoes are spoon-shaped at each end and are entirely different from the ocean canoes of the coast They are poled where the river is too swift for paddling A stranger's best policy is to sit on the bottom of the canoe and leave its management to the Indian owner.

At Bella Coola they found an old man carving spoons out of alder wood and an old woman weaving strips of cedar bark into mats Indians from the interior come to Bella Coola They look different from those of the coast, are more active and angular The costumes of both men and women are slightly different from those of the people of the coast They wear moccasins, which are not used by the Bella Coola or their neighbors, who spend much of their time in the surf and on the beach

The longest stay was made at Wrangel, in the country of the Tlingit Indians, where are large numbers of totem poles, carved grave posts and mortuary columns

Kluckwan is a village of the Tlingit Indians on the old Dalton trail to the Klondyke Here they saw the Tlingit women making Chilkat blankets, This blanket, as is well known, is one of the most remarkable kinds of weaving done in North America. It is made from cedar bark and mountain goat wool and decorated with woven designs characteristic of the region In very ancient times the designs were of a geometric character, similar to those of the Tlingit baskets but the blankets which are seen to-day bear the animal motives common on the carved wooden boxes of these people

From Kluckwan, Mr. Smith returned to the Museum while Mr. Taylor continued his color studies for two distinct series of pictures in mural decorations planned to show Indian industries and Indian ceremonials, by visiting the Haida at Masset on the northern end of Queen Charlotte Island and the Nootka at villages along the western coast of Vancouver Island

TOTEM POLE OF RIVERS INLET INDIANS

WOODEN MONUMENTS OF THE NORTHWEST COAST INDIANS.

According to prominent writers the typical industry of each tribe serves as a means of commerce and trade among the neighboring tribes the conditions of the country naturally influencing its products for example, when the northern Indian is weaving blankets out of mountain goat wool the southern Indian may be drying clams for the winter s food Therefore in the first series of paintings the effect will be made to show not only the industries but also the connections of these industries with those of other tribes These pictures will present the scenes where the material was procured how it was prepared and as far as possible the use of the finished article in trade

To gather the artistic and scientific data for the first painting of the series showing the weaving of the Chilkat blanket search was made through many towns and villages often in vain because the weather beaten and adz carved boards of the old houses had their original color hidden under white man s paint In Wrangel Mr Taylor made many color notes valuable to his work and he got the remainder of the subject in the Chilkat River section at Kluckwan where two old women seated in their peculiar fashion on their heels were creating a blanket stripping the cedar bark for warp and spinning the wool from the crude wool of the mountain goat

The Queen Charlotte Islands have long been inhabited by the most skillful builders of canoes enormous dugouts from cedar trees An Indian engaged at this work is represented in the accompanying view Although no canoe was being built while he was there one six fathoms long had been made the previous winter The Indians were still interested in it and manifested considerable pride in showing their work Urged on by their pride they carefully explained details and in many cases excellently illustrated them as a result of which dozens of pencil compositions and many local color notes were gained so that the Haida painting will show graphically the Indians at work carving and steaming the canoe in the midst of characteristic surroundings

On the way to Nass River they were informed that a native artist lived at Georgetown To learn that a picture painter not a mere decorator existed among these serious minded peoples who are accustomed to make only abstract designs stimulated their interest They finally reached the shack of the artist and watched by a large and curious family were ushered into his studio He exhibited odd bits of broken glass which when held toward the light showed strange drawings in color sometimes almost caricatures Yet they held a certain charm telling tales of legendary battles or of wonderful ceremonials In spite of the difficulties in the way of his work the man was a true artist an eager spirit in a race where enthusiasm is rare

Mr Taylor found that since the traders have taken away from the Indians all the skins and furs tribal currency has been limited to blankets though to a large extent it has given place to the money of the United States and Canada He saw the Kwakitul Indian still using blankets for exchange in their potlatches It must have been no unusual thing in the past to see ornamented natives unload canoes full of blankets while groups of waiting financiers stood in picturesque arrangement before their houses and totem poles The Tlingit exchanged their Chilcat blankets for Haida canoes (The making of a Chilcat blanket with an Indian woman at the frame is depicted in the half tone) The Haida traded their canoes for the eulichon grease of the Tsimshian The Bella-Coola who were the bread makers exchanged their bread with neighboring tribes Thus through all the coast tribes Taylor found a distribution of industrial products going on and to-day the results of this commerce are evident for in the extreme south one finds the work of the tribe living farthest north and *vice versa*

JACQUARD LOOM IMPROVEMENT

Interested circles have long been devoting attention to the possibility of weaving without cards and in still more recent times to the weaving of fancy patterns in various colors by the aid of electricity Certain inventions have been patented in this connection and these have now been brought into a practical form The chief object of the inventions in question has been to avoid the troublesome work in lifting the corresponding pattern cards out of the design frame After several years' work success has at last been attained and a machine has been constructed which is able to produce a piece of material bearing a pattern or design taken from an ordinary drawing As the principle of this invention is such that it can be applied to a very wide field and as it is also possible to reproduce in woven design photographs of pictures with all their lights and shades quite a new field for Jacquard weaving will be called into existence If it also be remembered that with the aid of the three-color process it will in addition be possible to weave designs in natural colors. It will also be seen that in future many difficulties which have so far been obstacles to Jacquard weaving will now be entirely avoided. The invention in question relates to an artificial card, this being done by electric power transferred to the needles of a Jacquard loom. In other words the Jacquard loom has now been altered in such a way that, instead of the usual Jacquard cylinder mechanism is employed for the transmission of the electric energy mentioned above. A German professor (Prof. Regel) has now built such a machine at a factory, and we hear that the invention will shortly be in practical use.

MENDELEEFF'S LIFE AND WORK.[*]

THE CAREER OF A GREAT CHEMIST.

Dmitri Ivanovitsch Mendeléeff was the fourteenth and youngest child of his parents Ivan Pavlovitsch and Maria Dmitrievna, née Korniloff. His father, a former student of the Chief Pedagogic Institute of St. Petersburg, obtained the appointment of director of the gymnasium at Tobolsk in Siberia, where he met Maria Dmitrievna, who became his wife. After a few years at Tobolsk he was transferred to school directorships in Russia, first at Tambov and afterward at Saratov, but in order to satisfy the ardent wish of his wife he took advantage of an opportunity of exchange by which he became once more director of the college at Tobolsk, and the family returned to Siberia. Here, on January 27th, 1834 (O.S.), was born Dmitri Ivanovitch, the youngest son. Soon after his birth the father became gradually blind from cataract in both eyes, and was obliged to resign, the whole family, including eight children, having to subsist on a small pension of 1,000 roubles (about £100 per annum). The mother, Maria Dmitrievna, belonged to the old Russian family Korniloff, settled at Tobolsk. They were the first to establish in Siberia the manufacture of paper and glass. In 1787 the grandfather of Dmitri opened at Tobolsk the first printing press, and from 1789 produced the first newspaper in Siberia, the Irtysch. The glass works were situated in the village of Aremziansky, a short distance from Tobolsk.

There can be no doubt the mother was a woman possessed of remarkable vigor of mind, who exercised great influence over her children. Her activity and capacity are further illustrated by the fact that when her husband became blind she revived the business of the glass works and carried it on until after his death from consumption in 1847.

Tobolsk was at that time a place of banishment for many political exiles, the so-called Decembrists, one of whom, Bassargin, married Olga, an elder sister of Dmitri. To these Decembrists the boy owed his first interest in natural science. His mother had always cherished the hope that at least one of her children would devote himself to science, and accordingly after her husband's death and the destruction of the glass works by fire, and in spite of failing health and scanty means, she undertook the long and tedious journey from Tobolsk to Moscow, accompanied by her remaining children, Elizabeth and Dmitri Ivanovitsch, with the object of entering the latter, then nearly fifteen years of age, at the university. Disappointed in this object, owing to official difficulties, she removed in the spring of 1850 to St. Petersburg, where ultimately, with the assistance of the director Pletnoff of the Central Pedagogic Institute, a friend of her late husband, she succeeded in securing for her son admission to the physico-mathematical faculty of the Institute, together with much-needed pecuniary assistance from the government.

The debt which Dmitri Ivanovitsch owed to his mother he acknowledged later in the introduction to his work on "Solutions," which he dedicated to her memory.

In the Pedagogic Institute Dmitri Ivanovitsch was thus able to devote himself to the mathematical and physical sciences under the guidance of Profs. Lenz and Kupfer in physics, Woskresensky in chemistry, and Ostrogradsky in mathematics. Unfortunately at the end of his course his health failed, and about this time his mother died. Having been ordered to the south, he fortunately obtained an appointment as chief science master at Simferopol in the Crimea. The southern climate soon alleviated the serious symptoms of lung disorder, and removal being necessary in consequence of the Crimean war, he was able soon afterward to undertake a post as teacher of mathematics and physics at the gymnasium at Odessa. In 1856 he returned to St. Petersburg, and at the early age of twenty-two was appointed privat docent in the University, having secured his certificate as master in chemistry.

At this time he appears to have passed rapidly from one subject to another, but he soon found matter for serious and protracted study in the physical properties of liquids, especially in their expansion by heat, and when in 1859, by permission of the Minister of Public Instruction, Mendeléeff proceeded to study under Regnault in Paris and afterward in Heidelberg, he devoted himself to this work, communicating his results to Liebig's Annalen and the French Academy of Sciences. Returning two years later to St. Petersburg, he secured his doctorate, and was soon afterward appointed professor of chemistry in the Technological Institute. In 1866 he became professor of general chemistry in the University, Butlerow at the same time occupying the chair of organic chemistry.

As a teacher Mendeléeff seems to have possessed a special talent for rousing a desire for knowledge, and his lecture room was often filled with students from all faculties of the University. Many of his former students remember gratefully the influence he exercised over them.

One of Mendeléeff's most remarkable personal features was his flowing abundance of hair. The story goes that before he was presented to the late Emperor, Alexander III, his Majesty was curious to know whether the professor would have his hair cut. This, however, was not done, and he appeared at Court without passing under the hands of the barber. His habit was to cut his hair once a year in spring, before the warm weather set in. His eyes, though rather deep set, were bright blue, and to the end of his life retained their penetrating glance. Tall in stature, though with slightly stooping shoulders, his hands noticeable for their fine form and expressive gestures, the whole figure proclaimed the grand Russian of the province of Tver.

At home Mendeléeff always wore an easy garment of his own design, something like a Norfolk jacket without a belt, of dark gray cloth. He rarely wore uniform or evening coat, and attached no importance to ribbons and decorations, of which he had many.

As to his views on social and political questions, many people thought him a rigid monarchist, but he said of himself that he was an evolutionist of peaceable type, desiring a new religion, of which the characteristic should be subordination of the individual to the general good. He always viewed with much sympathy what is called the feminine question. At the Office of Weights and Measures he employed several ladies, and about 1870 he gave lectures on chemistry to classes of ladies.

Mendeléeff held decided views on the subject of education, which he set forth in several publications, especially "Remarks on Public Instruction in Russia" (1901). Here he says: "The fundamental direction of Russian education should be living and real, not based on dead languages, grammatical rules, and dialectical discussions, which, without experimental control, bring self-deceit, illusion, presumption, and selfishness." Believing in the soothing effect of a vital realism in schools, he considered that universal peace and the brotherhood of nations could only be brought about by the operation of this principle. Speaking of the reforms desirable, he says that "for such reforms are required many strong realists; classicists are only fit to be landowners, capitalists, civil servants, men of letters, critics, describing and discussing, but helping only indirectly the cause of popular needs. We could live at the present day without a Plato, but a double number of Newtons is required to discover the secrets of nature, and to bring life into harmony with the laws of nature." Mendeléeff was evidently a philosopher of the same type as our own Francis Bacon.

In 1863, when twenty-nine years of age, Mendeléeff married his first wife, née Lestshoff, by whom he had one son, Vladimir[*], and a daughter, Olga, but the marriage proved unhappy, and after living apart for some time there was a divorce. In 1881 he married a young lady artist, Anna Ivanovna Popova, of Cossack origin, and lived first at the University, and afterward in the apartments built for the director at the Bureau of Weights and Measures. Here his younger children were born: Lioubov (Aimée), Ivan (Jean), and the twins Maria and Vassili (Basile).

In 1890, in consequence of a difference with the administration, Mendeléeff retired from the professorship in the University. During the disturbances among the students in that year he succeeded in pacifying them by promising to present their petition to the Minister of Education. Instead of thanks for this service, however, the professor received a sharp reprimand from the authorities for not minding his own business. The consequence was that Mendeléeff resigned. Independently of the petition, however, there were probably deeper reasons for his being out of favor with the Ministry, connected with his irreconcilable enmity to the classical system of education already referred to. Of this he made no secret, and it had already brought him into conflict with the authorities. In 1893, however, he was appointed by M. Witte to the office of Director of the Bureau of Weights and Measures, which he retained until his death.

Such are the chief features of a great personality. If it be admitted that stories are told of his occasional irritability of temper, we can well place on the other side of the account the cordial relations always subsisting between the professor and his assistants, the confidence and respect between the master and his servants, the deep affection between the father and his children, which are known to have persisted throughout his life, and which could be illustrated by many anecdotes. These stories merely serve to give the world assurance of a man.

For us who live on the other side of Europe, separated as we are by race, by language, by national and social customs, and by form of government, it is not easy to understand completely the texture of such a mind, the quality of such genius, and the conditions, social or political, which may have served to encourage or to repress its activity. The Russian language may be eloquent, expressive, versatile, and harmonious, or it may possess any other good quality that may be claimed for it by those to whom it is a mother tongue, but the fact remains that it is a barrier to free intercourse between the Russian people and the world outside the Russian empire. This alone creates a condition which must influence the development of thought, and must give to Russian science and philosophy a color of its own. Mendeléeff was, like many educated Russians, a man of very liberal views on such subjects as education, the position of women, on art and science, and probably on national government. We can hardly guess what would be the influence on such a nature of a rigid administrative *régime* which forbids even the discussion of such questions. We in England are almost unable to imagine such a state of things as would be represented by the closing of, say, University College for a year or more because the question whether the House of Lords ought to be abolished had been debated in the Students' Union. Imagine the professor of chemistry, along with his colleagues, for such a reason deprived of the use of his laboratory by the police, and only allowed to resume his studies when someone down at Scotland Yard thought proper. Such being the experience of most of the Russian universities and technical high schools, it is not surprising that the output of Russian science, notwithstanding the acknowledged genius of the Russian people, appears sometimes comparatively small. The amount of work done by Mendeléeff, both experimental and theoretical, was prodigious, and all the more remarkable considering the cloudy atmosphere under which so much of it was accomplished.[*]

In 1882 the Royal Society conferred on Mendeléeff, jointly with Lothar Meyer, the Davy medal. In 1883 the Chemical Society elected him an honorary member, and in 1889 it conferred upon him the highest distinction in its power to award, namely, the Faraday lectureship, with which is associated the Faraday medal. In 1890 he was elected a Foreign Member of the Royal Society, and in 1905 he received the Copley medal. So far as England is concerned his services to science received full acknowledgment. It is all the more remarkable therefore that he never became a member of the Imperial Academy of Sciences of St Petersburg.

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[*] The Mendeléeff Memorial Lecture delivered before the Chemical Society on October 21, 1909, by Sir William A. Tilden, F.R.S. Abridged from the Journal of the Society for December, 1909.

[†] For many of the details of Mendeléeff's career and of his home life the writer is indebted to the family chronicle compiled soon after his death by his niece N. J. Gubkina (née Kapustina) and published in St. Petersburg; also to pamphlets by A. Archangelsky and J. T. [illegible]. He also desires to express his thanks to Mr. D. A. Iéquier of St. Petersburg, as well as to several Russian friends, for valuable assistance in translation.

[*] Died in 1899, aged thirty-four.

[*] Prof. Walden, at the end of a biographical notice recently published in the Berichte d. Deut. Chem. Ges., April, 1909, gives a list of 262 printed publications by Mendeléeff. These include not only memoirs on physical and chemical subjects, but books, pamphlets, reports, and newspaper articles relating to exhibitions, to the industries of Russia, to weights and measures, to education, to art, and even to spiritualism.

Toward the end of 1906 Mendeléeff's health began to fail. Nevertheless he was able to attend the Minister on the occasion of an official visit in January to the office of Weights and Measures but he caught cold and enfeebled as he had been by influenza in the preceding autumn inflammation of the lungs set in. Retaining consciousness almost to the last he requested even on the day of his death to be read to from the Journey to the North Pole by his favorite author Jules Verne. He died in the early morning of January 20th (O S) 1907 within a few days of his seventy third birthday. He was buried in the Wolkowo Cemetery beside the graves of his mother and son.

Turning now to a survey of Mendeléeff's work as a man of science it will be sufficient if we pass lightly over his first essays. Like so many other chemists he began by handling simple questions of fact his first paper dated 1854 when he was twenty years of age being on the composition of certain specimens of orthite. It was not until 1859 that he settled down to serious examination of the physical properties of liquids which led him to a long series of experiments on the thermal dilatation of liquids of which the chief ultimate outcome was the establishment of a simple expression for the expansion of liquids between 0 deg and the boiling point. This formula is liable to the same kind of modification which has been found necessary in the case of gases. It is of course applicable only to an ideal liquid from which all known liquids differ by reason of difference of chemical constitution and consequent differences of density viscosity and other properties.

Mendeléeff devoted a large amount of time and of experimental skill to the estimation of the densities of various solutions especially mixtures of alcohol and water and of sulphuric acid and water and of aqueous solutions of a large number of salts. In 1889 he embodied the whole in the monograph already referred to. In a paper communicated to the Transactions in 1887 (li 779) he stated his views in the following words: 'Solutions may be regarded as strictly definite atomic chemical combinations at temperatures higher than their dissociation temperatures. Definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences; the same phenomenon occurs in solutions at ordinary temperatures they can be either formed or decomposed.' These views however did not prevent his recognizing Van 't Hoff's gas theory as applicable to dilute solutions.

In conjunction with some of his students Mendeléeff also studied minutely the question of the elasticity of gases and published several papers on the subject (see Royal Society Catalogue) extending over a period of some ten years from 1872.

Another subject to which Mendeléeff gave a good deal of attention was the nature and origin of petroleum. Having already reported in 1866 on the naphtha springs in the Caucasus in the summer of 1876 he crossed the Atlantic and surveyed the oil fields of Pennsylvania. In the course of these investigations he was led to form a new theory of the mode of production of these natural deposits. The assumption that the oil is a product of the decomposition of organic remains he rejects on a variety of grounds which are set forth in a communication to the Russian Chemical Society (Abstract see Ber 1877 x 229). Mendeléeff assumes as others have done that the interior of the earth consists largely of carbides of metals especially iron and that hydrocarbons result from the penetration of water into contact with these compounds metallic oxide being formed simultaneously. The hydrocarbons are supposed to be driven in vapor from the lower strata where temperature is high to more superficial strata where they condense and are retained under pressure. In 1886 in consequence of rumors as to the possible exhaustion of the Russian oil fields he was sent by the government to Baku to collect information and in 1889 he made a communication on this subject to Dr Ludwig Mond which is printed in the Journal of the Society of Chemical Industry (1889 viii 73).

The influence of the great generalization known as the periodic law can best be estimated by reviewing the state of knowledge and opinion before the announcement and acceptance of the principle by the chemical world and subsequently glancing at the influence which directly or indirectly it has produced on scientific thought not only in regard to the great problems to which it immediately relates but to the whole range of chemical theory.

The use of the expression atomic weight implies the adoption of some form of atomic theory but forty or more years ago Dalton's atomic theory was by many of the most philosophical chemists and physicists regarded as only a convenient hypothesis which might be temporarily useful but could not be accepted as representing physical reality. Since that time however a variety of circumstances has contributed to consolidate the Daltonian doctrine. The estimation of the ratios called atomic weights has been the subject of research attended by more and more elaborate precautions to secure accuracy from the time of Dalton himself onward through successive generations down to the present day. Though the atomic weights of the majority of the common elements are now known to a high degree of accuracy the acknowledged errors have been sufficiently great to render abortive various attempts to reduce them to any common scheme of mathematical relationship. As is well known the most important step toward the systematization of atomic weights was taken about 1860 mainly on the grounds eloquently and convincingly set forth by Cannizzaro* in consequence of which the arbitrary selection of numbers for atomic weights was superseded by the practical recognition of the law of Avogadro and the application of the law of Dulong and Petit so that a common standard was established. No general scheme of atomic weights was previously possible partial and imperfect efforts in this direction being represented by Dobereiner's triads and the principle of homology made use of by Dumas. Only so soon as numbers representing the atomic weights of calcium barium lead and other metals were corrected and brought into the same category as those of oxygen sulphur and carbon was there some chance of determining whether these numbers possessed a common factor or were capable of exhibiting mathematical interrelations which might be regarded as symbolic of physical relations or even directly dependent upon them. The first step in this direction was taken by J A R Newlands who after some preliminary attempts in 1864 discovered that when the elements are placed in the order of the numerical value of their atomic weights corrected as advised by Cannizzaro the eighth element starting from any point on the list exhibits a revival of the characteristics of the first. This undoubtedly represents the first recognition of the principle of periodicity in the series of atomic weights but whether discouraged by the cool reception of his law of octaves by the chemical world or from imperfect apprehension of the importance of this discovery Newlands failed to follow up the inquiry. It was not long however before the matter was taken up by others and doubtless the improvements in the estimation of atomic weights following on the work of Stas then only recently published inspired greater confidence in the approximate accuracy of the numbers adopted as atomic weights and thus encouraged inquiry into their relations. The subject is indeed an attractive one for it involves considerations which lie at the foundations of all our notions respecting the physical constitution of matter and accordingly we find papers by many chemists dealing with the question of these numerical relations. Odling especially seems to have given much thought to the subject and ignoring Newlands's previous attempts he drew up toward the end of 1864* a table containing all the at that time well known elements arranged horizontally in the order of their generally accepted groups and perpendicularly in the order of their several atomic weights. He concludes an article in Watts's Dictionary a few months later with these words: Doubtless some of the arithmetical relations exemplified in the foregoing table are merely accidental but taken altogether they are too numerous and decided not to depend on some *hitherto unrecognized* law. It is important to note the words I have italicized.

Such then was the state of knowledge about this time. Evidently the way was being prepared but the prophet had not made his appearance—the seer who could look with the eyes of confidence beyond the clouds of uncertainty which obscured all ordinary vision.

(To be concluded.)

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* 1858 and later Faraday Lecture 1872.

* Quart J Sci 1864 i 644 and Watts Dictionary vol iii [illegible]

THE PURPLE OF THE ANCIENTS.

Most highly prized among the ancients of all the dyestuffs known to them was the so called purple a color prepared from certain marine snails. Our knowledge of this substance is derived largely from Greek and Roman writings but there can be no doubt that the origin of the art of making and using this dye lies far back in remote antiquity. The Greeks themselves ascribed the discovery of the dye to their mythological hero Hercules, whose dog picked up a snail on the shore, and breaking the shell disclosed to his master the staining properties of the mollusk. As a matter of fact the art of dyeing with purple seems to have been introduced by the Phenicians and it is among the Semitic races that the earliest records relating thereto have been found. According to Dedekind a passage in an ancient Egyptian poem dating from 1400 B C must be construed as referring to the purple snail. In the Old Testament too, we read of curtains of purple draping the entrance to the Holy of Holies in Solomon's temple. And the same source tells of purple robes of state worn by the high officials of the Persian king.

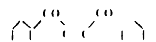
With the growth of civilization among the Mediterranean nations, and the increase of wealth the use of purple became more general, and at the time of the Roman empire had degenerated into a luxury indulged in without moderation by the rich. Nevertheless the wearing of special forms of purple garments remained the privilege of certain classes the "purpurati."

After the overthrow of Rome by the barbarians the industry became centered principally at Constantinople, where it was carried on under royal monopoly and gradually degenerated and finally became practically extinct. It is for this reason that only among very early manuscripts dating from the twelfth and thirteenth centuries so called codices purpurei written upon parchment dyed with purple are found.

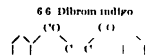
Strangely enough we have but a vague idea of the actual color and appearance of the proverbial purple of the ancients. One result of this is that as a designation of a modern color there is considerable divergence in the significance of the word purple as used in English and the corresponding 'pourpre' in French and 'purpur' in German. These latter correspond more nearly to our crimson. It is very probable that the most valuable purple was a very dark color almost black with a bluish or reddish violet sheen by reflected light. But it seems that there were also lighter shades, produced by the admixture of various substances to the dye. The true color of the ancient purple could of course be established beyond doubt if it were possible to follow out some of the old recipes. Unfortunately this is not feasible. The available data as found especially in Pliny's writings, are too vague, and in part quite unintelligible. This only is known with certainty that the species of snail named by Pliny 'purpura' is known in modern zoology as Murex brandaris while the bucinum of Pliny is a species of purpura probably P hemostomata.

Nothing definite is known as to the amount of raw material which was required to make a pound of the dye. But it must have been very large and this was no doubt the reason for the excessively high price of the product. As regards this we are told that at the time of Diocletian the best qualities of purple wool sold at $238 per pound. When we reflect that such material would contain only 4 to 5 per cent at most of the dye we see that our modern producers have cause to envy the makers of those days for the prices which they could command.

As regards the chemistry of purple little was known until quite recently. The writer secured a good supply of the raw material from a number of zoological experiment stations on the Mediterranean. He suspected that the dye might be an indigo derivative and a study of the chemical and physical properties of the substance have confirmed this. The analysis brought out the somewhat unexpected and surprising fact that there is quite a high proportion of bromine present. In fact the substance is 6 6 dibrom indigo whose structural formula is given below together with that of indigo.



6 6 Dibrom indigo



Indigo

It is interesting indeed to note that the famous dye of the ancients is so close a relative to one of our most valued coloring matters to-day namely indigo. The same indigo which but a few years ago was put upon the market as a synthetic product born in the chemical laboratory threatening the life of the old natural indigo industry and furnishing a most brilliant example of the triumphs gained in the industries over the old empirical methods by the applications of modern science.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Zeitschrift fuer Angewandte Chemie.

INSTANTANEOUS MICROPHOTOGRAPHY.

ITS APPARATUS AND TECHNIQUE.

INSTANTANEOUS microphotography presents very great interest, especially when it is desired to fix exactly the forms of certain living microscopic animals, such as infusoria, which cannot be made motionless by chemical reagents without greatly changing their appearance, often to such a degree as to make them unrecognizable. It is particularly difficult to seize the images of these microscopic creatures, the movements of which are very rapid and are exaggerated in proportion to the enlargement. The principal object of all the special apparatus used in microphotography is to permit the operator to observe, by means of a special eye piece, the object to be photographed, so that he can make the exposure exactly at the moment when, owing to the combined motions of the microscope stage and the focusing screw, the object is both in a good position and sharply defined.

From what was said above concerning the rapidity of the movements of infusoria, it will be seen that it is necessary to use a so-called instantaneous exposure, which must be made shorter in proportion to the degree of enlargement.

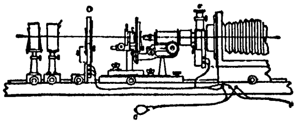


FIG. 1.—BRIANDEAU'S APPARATUS FOR INSTANTANEOUS MICROPHOTOGRAPHY.

As the brightness of the image diminishes in the same proportion, very powerful sources of illumination, such as the sun or the electric arc, must be employed. In the path of the incident beam it is necessary to interpose a vessel filled with a transparent liquid (glycerine or a solution of alum) for the purpose of absorbing the greater part of the rays of long wave length, which would kill the animalcules by heating the liquid which contains them. The eye of the observer must be protected against the action of this very brilliant illumination by covering the eye piece with smoked glass.

In order to overcome all these difficulties, Briandeau has designed the apparatus described below, with which he has obtained really remarkable results. The special features of the apparatus are two shutters connected with a device for simultaneous vision of the object. These two shutters, the first of which, strictly speaking, serves only to diminish the intensity of the illumination during the ocular observation, are electrically connected with each other, so that the second shutter operates automatically immediately after the first. The first shutter *O* (Fig. 1) is pierced by a circular opening, the center of which coincides with the optical axis of the microscope. To the shutter is attached a vertical groove, in which slides a sheet of metal having two apertures which can be placed in succession opposite the hole in the shutter. The upper aperture in the metal plate is entirely open, while the lower one is covered with a smoked glass of any desired tint, so that the light passing through it is diminished sufficiently to allow the object to be viewed directly without fatigue, and to protect the organisms in the preparation from the injurious effects of excessive light. When the shutter *O* is set ready for action, this smoked glass is interposed in the path of the luminous beam. At this moment a spring *r* (Fig. 3) presses upon a contact piece *c* and establishes an electric connection between the battery *P*, the releasing mechanism of the shutter *E* and the key *C*, which is pressed by the operator at the moment which he judges most opportune for the exposure. The shutter, being thus released, slides downward by its own weight and allows the beam of light to pass with undiminished intensity through the upper aperture. When the shutter arrives at the end of its course its lower edge presses the spring *r* toward the left, breaking the contact *c*, but establishing through the contact *c* an electric circuit which extends directly from the battery to the releasing mechanism *E* of the second shutter *O′*, which is really the true photographic shutter that permits the luminous pencil produced by the magnifying optical system to form the image on the photographic plate. This second shutter *O′* is placed as near as possible to the projecting lens of the eye-piece (Fig. 2). The shutter consists of a semi-circular plate, having an opening considerably larger than that of the external diaphragm of the eye-piece. By the side of the aperture is placed a total reflection prism, so arranged that when the shutter is set the pencil of light emerging from the eye-piece is deflected at right angles and along the line of sight of a small telescope, which can be adjusted in such a manner that the image seen directly is as sharp as the image projected upon the sensitive plate of the camera.

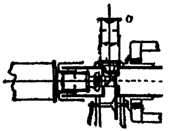


FIG. 2.—EYEPIECE, SECOND SHUTTER AND FINDER.

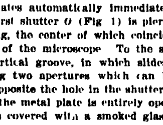


FIG. 3.—ELECTRICAL CONNECTIONS.

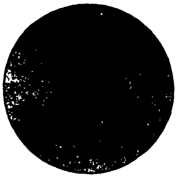


FIG. 4.—INSTANTANEOUS PHOTOGRAPH OF A WHEEL ANIMALCULE.

(Magnified about 100 diameters.)

The two shutters having been set, the animalcule to be photographed is selected, followed and kept in focus until the moment which is deemed favorable for making the picture. The operator then presses the electric key *c*, the effect of which is to release the first shutter *O*, the fall of which in turn releases the second shutter *O′* as soon as the illuminating beam of light has been entirely unmasked. Very interesting results can be obtained with this comparatively simple apparatus.—La Science au XXme Siècle.

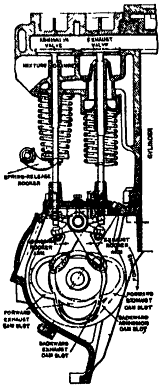
A NOVEL REVERSING GASOLINE ENGINE

THE Howaldswerke, of Kiel, Germany, has developed a reversible internal-combustion engine which embodies some interesting features.

It is a vertical, single-acting four-stroke engine, operated by any volatile fuel, such as benzine, gasoline, or even alcohol. The cylinders are bolted to a closed crank case, and provided with removable heads. As shown both the barrel and the head are provided with water jackets.

The piston, which is of the trunk type, ground to its final diameter, is provided with packing rings of cast iron. The piston pin is of hardened steel, ground to size. The crank shaft is of high grade steel, forged in a single piece, and runs in bearings of ample dimensions, which are lined with white metal. The cam shaft, which rotates at half the speed of the crank shaft, is located parallel to the latter, from which it is driven through the usual spur gearing. From the cam shaft is driven all the accessory mechanism of the motor—valves, pumps, and ignition devices. Separate suction and main-admission valves are provided, the latter being operated from the cam shaft, while the former are driven either in the same manner or independently of that shaft, being opened by the vacuum produced in the cylinder by the motion of the piston, and closed by a spiral spring as soon as this vacuum ceases. The mechanically-operated valves are operated through slotted cam disks mounted on the cam shaft. The valves are all made of nickel steel, and the automatic suction valves used on the small engines are of a specially practical and light construction, allowing of a rapid opening and closing, and reducing the resistance to the gas flow.

The figure shows the arrangement of the reversing valve gear. Slotted cam discs are mounted on the cam shaft for actuating the admission and exhaust valves. Each disk is provided on one of its plane faces with two cam slots, in which moves a slide pivoted on one arm of a bell crank, the other end of which lifts the valve stem. These slots are so designed that the valves are lifted uniformly with both directions of rotation. The slide and the slots are so designed that the former is compelled to move in the slot corresponding to the actual direction of rotation as long as that direction is maintained, but will automatically enter the slot corresponding to the other direction, as soon as the engine is reversed.



REVERSING VALVE GEAR OF ENGINE.

The engine is reversed simply by shifting the ignition timer, with any other manipulation of the engine. When the engine is running at slow speed, moving the "spark lever" to the "backward" position shifts the timer so as to produce ignition during the compression stroke, long before the piston has completed the stroke, and the back pressure on the piston is sufficient to overcome the inertia of the flywheel and reverse the direction of rotation. The succeeding ignition then is not advanced, but, owing to the reversal of the engine, becomes a late ignition. By then shifting the lever to the "full" position the timer is adjusted for the ignition to occur at the proper point to give maximum power. During reversal the load is thrown off, of course, by throwing out a flywheel friction clutch by means of a pedal.

On the cam shaft are also mounted two eccentrics which operate the cooling water and the oil pumps. The former is a piston pump with suction and pressure valves, provided with rubber disks to insure noiseless working, the latter is also a piston pump, but it is provided with ball valves. On the cam shaft is finally mounted the ignition timer. A battery current and an induction coil are used to produce high-tension current for "jump spark" ignition, and in the smaller engines this is the only ignition mechanism. In the large-sized engines there is also provided a magneto operated from the cam shaft through gears.

The fuel is gasified by a carbureter provided with means for regulating the mixture ratio for full and slow speed respectively, and the carbureter is warmed by means of the exhaust gases of the engine.

For use in marine service the motor is controlled by a maneuvering board mounted on a support, by means of a hand wheel and small lever, the motion of the wheel and lever being transmitted mechanically through wire ropes to the ignition timer and carbureter respectively.

A friction clutch, with disengaging forks, is arranged inside the flywheel and controlled by a pedal, allowing the propeller to be thrown into and out of gear with the engine, as in the case of an ordinary automobile clutch and transmission.—Power and the Engineer.

THE TRANSFER OF HEAT IN SOILS.*

AN INSTRUCTIVE INVESTIGATION.

BY HARRISON E. PATTEN.

The writer has recently investigated the absorption of heat by soils working out a new experimental and theoretical treatment of heat transference† which may prove of interest to others than soil investigators Hence an outline of the work is given here

At first sight it would seem very simple to insert a thermometer in the soil at any desired depth and read from it the temperature And so it is Much valuable information as to soil temperature and crop growth has been obtained in this way But if we attempt to find out just what climatic causes such as frost excessive heat rain snow wind velocity shelter from winds slope drainage exposure altitude humidity of atmosphere etc produce the degree of temperature observed at any point in a soil the problem becomes very complex Thus far the work both of practical soil investigation and of purely physical researches has failed to show the proper relation of the various causes to the travel of heat to and fro in a soil Some of these causes assist the flow of heat some on the other hand retard its progress

The energy available for all activity on the earth s surface comes to us from the sun and from other suns in space Just how this energy is transported across these tremendous distances for our use here on earth is a mystery We have found out experimentally however (1) that this energy arrives in a regular series of shocks and (2) that there are a number of different sorts of these series of shocks or waves They can be separated from each other giving the various kinds of light red blue violet etc heat electricity X rays etc Moreover these different forms of energy may be converted into each other

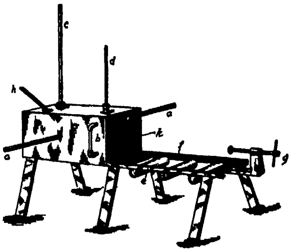


FIG 1—HEAT SOURCE USED IN THIS INVESTIGATION

Thus the energy in sunshine is practically all in the form of light or short waves but when it strikes the earth s atmosphere part of the sunshine is absorbed by the air in another form as heat Part of the sunshine is reflected back to stellar space and still another fraction of the sunshine passes down to the earth where it is partly reflected and partly converted to heat The heat then travels downward into the earth as more and more sunshine strikes and warms the surface When the sun begins to sink less and less sunshine strikes the earth and its surface cools until presently we have the stored heat of the day traveling back from the lower layers of soil up toward the surface The heat lost from the earth s immediate surface may be given forth not as heat but as radiant energy Consequently we may have a very hot day followed by a very cold night in regions where there is little moisture in the air This is because the hot soil gives off its heat again as radiant energy (not as heat) and thus the day s store of warmth escapes without warming up the night air But in moist regions the escaping radiant energy on meeting the water vapor in the air is converted back to heat Some of the sunshine on striking the earth serves to evaporate water and thus is converted by expansion of the vapor into mechanical energy condensation of this vapor to water as rain and sleet and snow liberates heat and in falling and moving through the air produces electricity, which we see occasionally in the form of lightning

It is evident then, that the actual quantity of heat supplied to the surface of the earth in any one spot depends upon many atmospheric conditions The continual change in each of these conditions from hour to hour renders difficult the estimation of an average value of the heat supplied to a given area of soil during a known interval of time In this case it seems that the most practical means of finding out the laws of heat flow through soil is not to work in the field where every condition we desire to study changes at its own will and in unknown degree but rather to know and control each of these conditions

Although measurement of soil temperature has been carried on in many countries for many decades there seems to be no investigation on record giving the rate of flow of heat through soil under controlled laboratory conditions where the moisture content packing (apparent specific volume) and effective specific heat are known In some cases accurate daily readings of the soil temperature have been taken to a depth of three feet or more through a series of years but no attempt made to measure even roughly the moisture content the apparent specific volume or the specific heat Other observers have recognized the need of all these additional factors and have at times secured data on them under field conditions but even then we can not calculate the heat conductivity of the soil from their readings with any degree of satisfaction since the moisture content varies with the depth and we must take temperature readings at several depths to determine the temperature wave

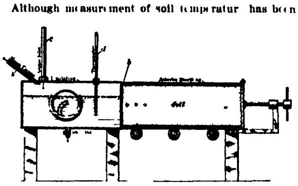


FIG 2—LONGITUDINAL SECTION OF HEAT SOURCE WITH SOIL BOX IN POSITION

The investigators in this line of work have been interested mainly in ascertaining the temperature of the soil at given depths during the growing season Some have tried the effect of various top dressings—manure admixtures mulches rolling etc —upon the soil temperature and many of these results are valuable and reliable since they were obtained under comparable though undetermined conditions Others too have recognized the part which the total quantity of available heat plays in the development of plants and attempts to measure this heat have been made by integrating the air temperatures close to the ground and integrating the sunshine Such calculations are also supplemented by an integration of the heat gained by the soil from day to day as the season progresses

From another standpoint geologists and astronomers have made daily measurements of temperatures at regular depths in solid rock for periods even approaching half a century on one single series and have accurately calculated the heat conductivity of the rock But such values for the heat conductivity of a homogeneous or compact rock conglomerate do not help much in estimating the conductivity of a soil

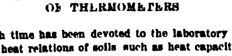


FIG 3—SOIL BOX SHOWING ARRANGEMENT OF THERMOMETERS

Much time has been devoted to the laboratory study of the heat relations of soils such as heat capacity and the effect of soil moisture upon it demonstration that the heat capacity of a powder consisting of different minerals each with its own specific heat is the sum of the heat capacities of its constituents the effect of top dressings and admixtures etc Especially interesting is the laboratory work of Petit upon the penetration of frost into soils He found that the phenomenon of supercooling such as is observed in the freezing of water in the form of drops or in capillary tubes also occurs in the freezing of soil water and may be as great as 3 deg C below the freezing point of water The lower the moisture content of the soil and the greater the energy with which the water is held by the soil the lower is the temperature to which soil water can be supercooled The passage of frost into the ground is fastest for quartz sand slower for clay and slowest for humus (peat) During continued frost the soil temperature sinks after freezing faster and deeper the lower the moisture content of the soil and conversely for the thawing of a soil Living or dead vegetation or snow protects from frost and retards thawing

The heat conductivities of dry powders and soils have been determined by numerous experimenters but the effect of moisture upon the heat conductivity has been treated only qualitatively Consequently an attempt was made in this investigation to establish a quantitative relation between the heat conductivity of a powder and its moisture content Since the apparent specific volume and effective specific heat of a powder are factors in determining its heat conductivity these too were determined in every case The rate of warming (diffusivity) of the powder of course was found in order to calculate the heat conductivity

The importance of such an investigation is apparent upon reading the reports of experiment stations generally both in this country and abroad since large sums of money and patient observation and experimentation are involved in the attempt to ascertain the relation of temperature in air and in soil to crop growth So long as the factors which control heat conduction remain undetermined as to their magnitude and direction of influence much of this field work upon soil temperatures will be in vain

Usually the heat conductivity of the earth s crust has been determined by taking the temperature of the earth at different depths as affected by the alternate heating and cooling at the surface due to the change from night to day and in a greater degree as affected by the progression of the seasons

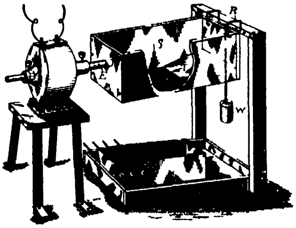


FIG 4 MECHANICAL PACKER SHOWING SOIL BOX BELOW

Such measurements give the temperature wave at each depth very well for the particular locality studied and when the specific heat of the dry soil the per cent of water and the specific volume (or packing) are known one may calculate the heat conductivity of the soil This calculation however involves the treatment of a periodic function which only approximates a sine curve since it is modified by a damping term as well as by other disturbing factors Consequently the heat conductivity calculated in this manner is at best an approximation Further as the heat wave penetrates into the earth distillation of moisture takes place accompanied by a change in packing so any method of measuring heat conductivity which requires the soil to be subject to a difference of temperature for a short period cannot be expected to give even approximately accurate results

The selection of a method for measuring the passage of heat through a moist soil under laboratory conditions involves a choice of the least of several evils There is no good method Briefly the situation is this If the heat be measured by extracting it from the soil distillation ensues and the soil crumb structure is altered If heat be added the same process is gone through in the reverse sense If alternate heat and cold be applied the soil changes its packing and may change its moisture content In the face of these conditions it was decided to supply heat from an infinite source at a constant temperature to the end of a soil column and take the rate of rise of thermometers at regular distances down the column and base a calculation of the heat conductivity upon the behavior of that portion of the soil which was sufficiently removed from the source of heat to be very little changed by distillation of its moisture and yet close enough to show the influence of the heat

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* Published by permission of the Secretary of Agriculture

† Bull. No 59, Bureau of Soils U S Department of Agriculture 1909.

The apparatus used in this method consists in the main of three distinct features (1) The heat source (2) the soil box and (3) the mechanical packing apparatus

(1) The heat source is a heavy rectangular brass tank 15 centimeters wide 12 centimeters deep and 20 centimeters long insulated with asbestos and felt on five sides one end being exposed to serve as a heat contact The tank is maintained at a constant temperature near 100 deg C by boiling water in it and allowing the steam to escape (F Fig 1) at atmospheric pressure For lower and higher temperatures different liquids may be used The liquid in the tank is very conveniently heated by a copper coil carrying live steam (a) which passes horizontally through the tank The steam exhausts into a drainpipe where it is condensed by running water The level of the water in the tank is shown by the gage *b* and as the water boils away the supply is replenished by the feed pipe *c* The temperature of the tank is given by the thermometer *d* and *f* are skids for the soil box and *g* is a screw clamp serving to press the soil box firmly in place against the heat source

(2) The soil box is built of pine wood boiled in paraffin and painted with asphaltum One end is made of copper Externally it has a coating of asbestos board cemented to the wood The end cross section inside the box is 10 by 10 centimeters Centigrade thermometers reading 110 deg are inserted through rubber stoppers in the sides of this box at intervals of 1 centimeter the even positions alternating with the odd positions on opposite sides of the box thus numbers 1 3 5 7 are on the right side of the box and numbers 2 4 6 on the left side (Fig 3) The thermometer bulbs are ranged along the central diameter of the box which is perpendicular to the plane of the heat source For some of the determinations thermometers were placed above and below this central diameter to ascertain the effect upon the rate of the temperature rise with time of departure from this central diameter

In making a determination the soil box is fitted with the thermometers and then filled with soil of definite moisture content from the mechanical packing device to be described below The soil box is then allowed to stand until the thermometers are nearly in a steady state at room temperature and the reading of each thermometer at zero time taken The copper end of the soil box (A Figs 1 and 2) is then placed against the heat source a stop watch pressed at the instant of contact and readings of time and temperature taken from each thermometer during a period which may cover twenty minutes or two hours depending upon the heat conductivity of the soil

(3) The mechanical packing apparatus used is shown in Fig 4 It consists of an electric motor whose shaft bears an eccentric collar *I* fitting into a hole in the end of a sieve S When the motor is going the sieve vibrates rapidly at its lower end the upper end being held in place by wire hooks *R* which engage a support and are kept in place by the pendant weight W The tin false bottom T feeds the soil to the screen which had three meshes to the centimeter in the work here presented The soil box (Fig) may thus be filled with soil under definite mechanical conditions In all the experimental determinations of heat conduction the soil was packed by means of this device, the height of the sieve above the soil box being always the same

Experiments made with different soil types show very well the general laws of heat transference in moist powders Wetting a dry powder increases its ability to conduct heat as much as three or four times The reason for this increase is simple solid sandstone transfers heat some ten times faster than the same stone ground down to small sand grains This is because air between the sand grains prevents the ready passage of heat from grain to grain When water is added to dry sand it places the sand grains in more intimate contact by forming a film of water which incloses each grain and fills more or less completely the angular spaces between them Thus the water film acts as a bridge from grain to grain Heat will pass from soil grain to water about 150 times easier than from soil grain to air, and besides the conductivity of water is much greater than that of air Consequently a moderately wet soil conducts heat very much better than a dry soil

As we add more water to a soil its grains gather into clusters This is due to the attempt of the water film which surrounds each grain and connects them to draw together and occupy as small an area as possible The forming of these clusters of grains leaves larger air spaces in the soil than those in a dry soil where the grains are not united And these large air spaces offer resistance to the passage of heat Thus the action of water upon soil first makes better contact between individual grains and then as more water is added it draws the grains into clusters (soil crumbs) and produces poorer contact between the clusters while at the same time better contact between the grains in each cluster is secured When sufficient water is present to form practically all the soil grains into clusters the soil is in a very open condition crumbly This is the most favorable condition for penetration by plant roots the large air spaces between the soil clusters permit ventilation and access of atmospheric gases necessary to plant growth The per cent of moisture in a soil which produces this most favorable structure of the soil grains is technically termed the Optimum water content*

When too much water has been added to a soil the excess is held between the soil grain clusters thus giving better contact and better heat conductivity Consequently the heat is better able to penetrate the soil and cause evaporation of water until the right quantity of water is left for plant growth However, a very large excess of water in a soil causes it to flow the soil clusters are broken down to very small clusters or to single soil grains In this condition the soil conducts heat much less well than when it has just enough water for good plant growth This is because the water itself has a heat conductivity about one seventh as great as that of the solid soil grains, and in addition the capacity of water for heat is five times greater than that of dry soil grains

The general effect of adding a liquid to a dry powder is first to increase its heat conductivity, and then as more and more liquid is added the heat conductivity increases to a maximum value and falls again to a lower value as the powder becomes soaked and finally flows The soaked soil however, has a much better heat conductivity than the dry powdery soil and soil containing the proper amount of water for plant growth has nearly the highest thermometric conductivity

This is another beautiful illustration of the adaptation of life to environment the structure and ventilation and moisture in a soil are all capable of being brought simultaneously into a highly favorable state for plant growth, and now it appears that a soil in this condition will also be warmest

A very interesting fact regarding the action of water upon dry soil has been carefully considered in all of this research It has been known for many years that heat is given out when a dry powder is moistened but no one has thought this quantity of heat important in determining the heat capacity of powders and soils The usual method of finding the heat capacity of a solid or solid powder is to heat a weighed quantity of solid to a known temperature and then drop the hot solid into a known weight of water A portion of the heat passes from the solid into the water thus warming it The number of degrees through which the water is warmed is read upon a sensitive thermometer immersed in it Thus we are able to calculate the heat capacity of the solid as compared to that of the water Now if a powder be treated in this manner to determine its heat capacity it gives out more heat than it would give in solid unpowdered condition In the case of a soil rich in organic matter the heat evolved on moistening the soil at room temperature was found to be one third of the total heat given out in determining the heat capacity of this soil by the method just described This means that the heat capacity of this soil and others like it, has therefore been given a value one third too high The old figure gave such a soil a heat capacity 0 24 of that of water which has the highest heat capacity of any known substance and therefore is chosen as the unit of heat capacity whereas the new figure obtained is almost 0 16 In all the soils studied this correction was made It is very considerable for soils containing much clay or organic matter and enters into the calculation of the heat conductivity as an important factor

The usefulness of the information gained by this investigation consists in pointing out the changes—heretofore unknown in heat conductivity of a soil to be expected when the moisture content and packing are varied rather than in furnishing rigid constants which may serve to calculate accurately the heat conductivity and diffusivity of a soil under any given conditions

The heat capacities (specific heats) of dry soils are not greatly different and if it were merely a question of ascertaining the moisture content and then calculating the specific heat of the mixture and estimating the heat conductivity from the individual heat conductivities of soil grain material and of water the problem would not be difficult But as shown above the degree of contact secured between soil grains depends upon several factors which are not capable of accurate measurement or control even under laboratory conditions The packing of a soil as well as its crumb structure (soil grain clusters) varies from point to point in the soil varies with the moisture content and with the temperature The proportion of fine grains to large grains in a soil also influences its behavior toward heat passage since the finer grains may wedge between the larger and serve to make contact between them Consequently it is not practicable to say beforehand what may be expected with any individual soil sample without experimenting directly with that particular sample

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* See Bull No [illegible] Bureau of Soils U S Department Agriculture

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THE SEXAGESIMAL SYSTEM AND THE DIVISION OF THE CIRCLE

By G A Miller

The division of the hour and the degree into 60 equal parts called minutes and the minute into 60 equal parts called seconds keeps fresh in our minds the fact that the ancient Babylonians used 60 as a basis of numeration Less than ten years ago all seemed to agree on the probable origin of this system It was assumed that the ancient Babylonians supposed that there were only 360 days in a year and hence divided the circle so that one day corresponded to each division In support of this hypothesis it was pointed out that the ancient Chinese divided the circle into 365¼ parts in their *Tcheou pei* and that this work could not have been written before 213 B C but at this early date the Chinese were already acquainted with the year of 365¼ days From the assumption that the circle was divided into 360 equal parts before the origin of the sexagesimal system and the fact that the radius of a circle can be applied exactly six times as a chord of the circumference it was easy to account for the base 60

In recent years this question has received considerable attention and many arguments have been advanced against the given hypothesis as regards the division of the circle These arguments appear convincing but it is not so easy to replace the old theory by one which is free from objections In the third edition of his classic Vorlesungen über Geschichte der Mathematik (1907 volume 1 page 37) Moritz Cantor accepts the hypothesis that the base 60 was selected as a consequence of the mingling in the Babylonian country of two ancient civilizations one employing 10 and the other 6 as a base of numeration In view of the difficulties which this hypothesis entails efforts have been made to find a more plausible one

Prof Edmund H Hoppe Hamburg Germany has recently advanced such a hypothesis* and has given a large number of historical facts tending to its support He assumes that the normal angle among the ancient Babylonians was an angle of an equilateral triangle and that it was observed at an early date that six such angles cover the entire area around a point Hence the number 6 assumed great importance being regarded to stand for completeness The base 60 could then have easily resulted from a division of the normal angle into ten equal parts After this base was established alongside the much older base 10, the normal angle itself was divided into 60 equal parts, and this led to the division of the circle into 360 equal parts

Whether this hypothesis will be generally accepted remains to be seen The fact that the ancient Babylonian wheel had six spokes while the ancient wheels in Egypt and Greece had only four tends to support the hypothesis that among the former an angle of 60 deg was regarded as normal, while the right angle was regarded as normal among the latter At any rate the hypothesis advanced by Prof Hoppe tends to throw additional light on a question which relates to our daily experiences but had not received a satisfactory answer —Science

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* Archiv der Mathematik und Physik, vol xv (1910) p 304.

Before the recent meeting of the American Society of Mechanical Engineers Prof Charles M Allen described a complete series of tests on a 2 inch meter, to determine whether a Venturi meter is sufficiently accurate under all conditions encountered in practice to be used to measure boiler feed The apparatus was set up in the most convenient way not only for weighing the water used, but also for heating it before it passed through the meter and for pumping Four sources of supply were used—an injector, a duplex pump a triplex power pump, and a pressure tank—all drawing water from a pit having a steam line to heat the water As the capacity of the pit was large an even temperature could easily be maintained The water was discharged into 5 000-pound weighing tanks after passing through the meter Cold water tests were first made, to determine the co-efficient of the meter, followed by tests with conditions the same as those in boiler rooms, the temperature ranging from 80 to 180 deg Fah, while the pressure also was varied by different arrangements of the auxiliary apparatus The results obtained showed that the meter tested was best adapted for use in a plant of over 200 horse-power, and, as the maximum and minimum variations noted were 3 and 9 82 per cent, respectively, the Venturi meter is adapted to measure hot water, provided the proper size is used.

HALLEY'S COMET.—II.*

BY FAR THE MOST INTERESTING OF THE PERIODIC COMETS.

BY GEORGE F. CHAMBERS, F.R.A.S.

Concluded from Supplement No. 1788, Page 239

The physical appearance of Halley's Comet at the 1835 apparition seems to have been in many respects very remarkable, and did the statements made not emanate from some of the most distinguished astronomers of the time it might be permissible to distrust them. It is impossible, however, to distrust anything stated by such men of skill and high character as Bessel, J. Herschel, W. Struve and Maclear. Struve compared the appearance of the nucleus about the end of the first week of October to a fan-shaped flame emanating from a bright point, and subsequently to a red-hot coal of oblong form. On October 12th it appeared like the stream of fire which issues from the mouth of a cannon at a discharge and when the sparks are driven backward by a strong wind. At moments the flame was thought to be in motion or exhibiting scintillations similar to those of an Aurora Borealis. A second small flame forming a great angle with the principal one was also remarked. On November 5th the nebulosity independently of the flames (two of them being visible) had a remarkable arched form somewhat resembling a powder horn. These phenomena under different and varying names were seen and commented upon by other astronomers, British and foreign. The previous installment by Admiral Smyth would seem to represent fairly well all the remarks made by the various astronomers just cited.

I have given these details respecting Halley's comet in 1835 at some length, thinking that they might be useful as hints as to what to look for in 1910.†

It will be interesting to consider what we know of the history of this comet anterior to the apparitions already mentioned. Halley, we have seen, satisfactorily traced back his comet to 1531, but since his time it has been traced very much further backward through a range indeed of some 11 centuries or more, first by the labors of Hind and Laugier, and quite recently by those of Cowell and Crommelin, confirming Hind for the most part and enlarging his results. The years in which identification may be regarded as more or less certain are the following:‡

Year	Interval in Years	Year	Interval in Years
B. C. 11.8	77.8	989.7	76.5
A. D. 66.0	75.1	1066.2	79.0
141.2	77.2	1145.3	77.6
218.2	77.0	1222.9	79.3
295.2	78.6	1301.8	77.0
373.8	77.6	1378.8	77.6
451.5	79	1456.4	75.2
530.8	76.5	1531.6	76.1
607.3	77.5	1607.8	74.9
684.8	75.6	1682.7	76.5
760.4	76.8	1759.2	76.7
837.2	75.0	1835.8	74.5?
912.2	77.4	1910.3?	

Cowell and Crommelin have found themselves justified in adding to this table backward the years B. C. 87 (May) and 240 (May), with no identification possible for the intermediate return in June, 163 B. C., though comets are vaguely mentioned in the years 166 and 165.

We owe the observations which have made these identifications possible mainly to Chinese records, supplemented more or less by European monastic chroniclers of various sorts and kinds, and by a few private authors. It would be tedious to transcribe any of the originals of these, even in an abridged form, indeed in point of fact their language is already generally so curt as to be incapable of abridgment, so a concise digest is all that will be offered to the reader, and this will be often given in the language of Hind§ and chronologically backward.

Halley surmised that the great Comet of 1456 was identical with his, and Pingré converted Halley's suspicion into a certainty. This comet was described by the Chinese as having had a tail 60 deg. long and a head which at one time was round and the size of a bull's eye, the tail being like a peacock's.

At the preceding return in 1378 the comet was observed both in Europe and China, but it does not appear to have been as bright as in 1456.

In 1301 a great comet is mentioned by nearly all the historians of the period. It was seen as far North as Iceland. It exhibited a bright and extensive tail which stretched across a considerable part of the heavens. Hind rejected the European observations of 1301, finding them to be of no good compared with the Chinese observations which proved consistent—a reversal of 20th century preferences.

The previous apparition was for some time a matter of doubt. Hind treated as Halley's a comet which appeared in July 1223 and was regarded as the precursor of the death of Philip Augustus, King of France. The records are vague and inadequate, and Cowell and Crommelin have given the preference to a comet which was seen in August and September 1222 and which passed its perihelion probably in September. The Waverley Abbey Annalist says that in the months named a fine star of the first magnitude with a long tail appeared. When first seen it was near the place where the Sun sets in December. The Chinaman Ma-tuan-lin says that on September 25th it came from η Bootis. The tail was 30 cubits long and the comet perished in two months. The question of the identification of one of these comets with Halley's is one of the few instances in which Cowell and Crommelin have dissented from Hind's identifications by deciding in favor of the Comet of 1222 in preference to Hind's 1223.

In April and May 1145 the European and Chinese chroniclers record a comet with a tail 10 deg. long, whose course among the stars from the end of April to the beginning of July is stated by Hind to have been perfectly in accord with the computed path of Halley's Comet, supposing the perihelion passage to have taken place about the third week in April. The Chinese accounts seem to speak of the July comet as being different from the April and May one, but whether this was so or not cannot be determined with any certainty. Hind seemed to regard the two to be one and the same.

In April of the year 1066, the year in which the Norman Conquest took place, a remarkable comet attracted the attention of all Europe. In England it was viewed with especial alarm, and the success of the Norman invasion and the death of Harold were attributed to the comet's baneful influence. Zonaras, the Greek historian, in his account of the reign of the Emperor Constantinus Ducas (whose death occurred in May 1067) describes a comet which was as large as the full moon, and at first was without a tail, on the appearance of which it (which presumably means the head) diminished in size. The transformation accords with the Chinese accounts, which describe the comet's path among the stars in Chinese fashion with great elaboration. The Chinese say that this object was visible for 67 days, after which the star, the vapor and the comet all disappeared. It seems fairly certain that this was Halley's Comet. At any rate it was immortalized in the famous Bayeux Tapestry.

In 989 a comet was observed in China which is mentioned also by several Anglo-Saxon writers. Burckhardt, the French computer, investigated its orbit and found that the elements bore a considerable resemblance to those of Halley's Comet. The perihelion passage was found to have occurred about September 12th.

Halley's Comet certainly appeared in 912, but there were two comets in this year, and Cowell and Crommelin differ from Hind in the identification, Hind selecting the earlier one and Cowell and Crommelin the later one, which appeared in the autumn.

Halley's Comet should have appeared in 827. There certainly was a comet in this year, but a comparison of the European and Chinese accounts, taken literally, implied that there were two comets in this year, one in perihelion in February and the other in April. The latter would seem to have been a most imposing object, but in Hind's opinion it could not have been Halley's Comet. The Chinese records indeed imply that there was a third or even a fourth comet in that year, in the months of June and September, but we need not discuss this question, which probably involves some misconceptions and which does not concern us in discussing Halley's Comet.

A comet appeared in 760 which without any doubt whatever was Halley's. It is recorded in detail both by European and Chinese annalists, and the orbit has been calculated and identified by Laugier. By European writers we are told that a comet like a great beam and very brilliant was observed in the 20th year of an Emperor Constantine, first in the E. and then in the W., for about 30 days. The Chinese give a visibility of two months. Laugier calculated the perihelion to have occurred on June 11th.

In 684 the Chinese record a comet observed in the W. in September and October. Hind pointed out that this statement would accord with the course of Halley's Comet when the perihelion occurs about the middle of October, and as the epoch for the reappearance of the comet is about what it should be, there is a fair probability in favor of the identity.

A comet observed by the Chinese in the constellations Auriga, Ursa Major and Scorpio in 608 was regarded by Hind as probably Halley's, who said that the track assigned would harmonize with a perihelion passage occurring about November 1st. Cowell and Crommelin, however, identified the Comet of 607 (?) as Halley's.

The previous return should have occurred about 530. There was a comet in that year, and none of the few circumstances connected with it recorded by the European chroniclers is contradictory to the theory which implies that the comet was Halley's. The Chinese records are silent as regards this year.

A comet appeared in 451 as to which there is little doubt that it was Halley's, according to the investigations of Laugier. It was seen in Europe about the time of the celebrated battle of Chalons, when the Roman general Aetius defeated Attila, the leader of the Huns, who had been ravaging central Europe. In China the comet was observed from the middle of May till the middle of July, during which period it moved from the Pleiades into Leo and Virgo, a track which agrees with the path which Halley's Comet would have followed if its perihelion passage took place on July 3d.

In 373 the Chinese annals record a comet in Ophiuchus in October which Hind thought would fit in with the probable position of Halley's Comet if the perihelion passage took place about the beginning of November. But another Chinese authority records a comet much earlier in the year, namely in March and April, which must have been visible all through the summer if it were the same as the October comet.

In 295 there was a comet observed in China, the identity of which with Halley's Hind thought to be nearly certain. It seems to have been visible in May after perihelion passage at the commencement of April.

In the year 218 a large comet is recorded both by European and Chinese chroniclers. Dion Cassius describes it as a very fearful star with a tail extending from the W. towards the E. The Chinese catalogue of Ma-tuon-lin gives it a path exactly in agreement with the path which would be followed by Halley's Comet when the perihelion falls about the first week in April. The description given is that it was pointed and bright.

In 141 the Chinese observed a comet in March and April, 6 or 7 cubits long and of a bluish white color. The elements of a comet following a path such as that described in some detail by the Chinese annalist would not be widely different from those of Halley's Comet, and the comet is the only one recorded about this epoch.

The preceding apparition should have taken place either in the summer of 65 or in the following winter of 65-66. The Chinese record two comets, one in July 65, which remained visible for 56 days, and the other in February 66, which remained visible 50 days.

Hind suggested that most likely the last named was Halley's Comet, if the perihelion passage took place at the end of January, and Cowell and Crommelin have definitely confirmed this. Not improbably this comet was the sword-shaped sign recorded as having hung over the city of Jerusalem before the commencement of the war which terminated in the destruction of the Holy City. Josephus says that several prodigies announced the destruction of Jerusalem. Amongst other warnings a comet of the kind called Xiphias, because their tails appear to represent the blade of a sword was seen above the city for the space of a whole year Josephus rebuked his countrymen for listening to false prophets while so notable a sign was in the heavens

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* The Story of the Comets Simply Told for General Readers. By George F. Chambers, F.R.A.S. Oxford: at the Clarendon Press. 1909.

† Drawings by Bessel will be found in the Ast. Nach., vol. xiii, Nos. 300-2, Feb. 10, 1836. Reference may also be made to the Memoirs of the Astronomical Society, vol. x (drawings by C. P. Smyth); Sir J. Herschel's Results of Astronomical Observations at the Cape of Good Hope; and Struve's Beobachtungen des Halleyschen Kometen.

‡ This table is from Hind, but altered where necessary to embrace the researches of Cowell and Crommelin. It should here be mentioned that some share of credit for these identifications is due to the French astronomer Laugier (Comptes Rendus, vol. xxiii, p. 183, 1846). Nor should the labors of Pingré and Burckhardt be forgotten in this connection.

§ Month. Not. R.A.S., vol. x, p. 51, Jan., 1850; The Comets, pp. 56-57.

Dion Cassius mentions a comet which seemed to be suspended over the city of Rome before the death of Agrippa The date would be B. C. 11 The path of this comet was recorded in great detail by the Chinese, and Hind thought that the records afforded "the most satisfactory proof that they belonged to the Comet of Halley" The third week in October was suggested for the perihelion passage The comet was lost in the Sun's rays [illegible] days after its discovery

Cowell and Crommelin have made systematic efforts to trace Halley's Comet back further and with some success, and it is not beyond the bonds of possibility that further identification will reward research because the Chinese records go back for six centuries before the Christian era, and besides them there exists a sprinkling of European observations although all these latter are very much lacking both in precision of language and precision of dates

THE PSYCHOLOGY OF PEOPLES.*

By Prof R S Woodworth

All in all the discovery of true inherent differences between races and peoples is an intricate task, and if we turn to the psychologist to conduct an examination of different groups and to inform us regarding their mental differences, we must not allow him to present a hasty conclusion His tests must be varied and thorough before we can accept his results as a serious contribution to this difficult subject The psychologist may as well admit at once that he has little to offer, for, though the 'psychology of peoples' has become a familiar phrase, and though books have been written on the subject actual experimental work has so far been very limited in quantity

One thing the psychologist can assert with no fear of error. Starting from the various mental processes which are recognized in his text books, he can assert that each of these processes is within the capabilities of every group of mankind All have the same senses the same instincts and emotions All can remember the past, and imagine objects not present to sense All discriminate, compare, reason and invent In all one impulse can inhibit another, and a distant end can be pursued to the neglect of present incitations Statements to the contrary denying to the savage, powers of reasoning, or abstraction, or inhibition, or foresight, can be dismissed at once If the savage differs in these respects from the civilized man, the difference is one of degree, and consistent with considerable overlapping of savage and civilized individuals The difference of degree calls for quantitative tests But besides the traditional classification of mental powers, there is another of perhaps greater importance in studying differences between men One individual differs from another not so much in power of memory or of reasoning, or of attention, or of will, as in the sort of material to which he successfully applies these processes One gives his attention readily to mathematics, he remembers mathematics easily; he reasons well on mathematical subjects; his will is strong in excluding distracting impulses when he is in pursuit of a mathematical goal. He may show none of these powers in a high degree, in relation to music or business or social life, whereas another, totally inefficient in mathematics, may show equal powers of mind in another subject. The capacity to handle a given sort of subject matter is in part determined by native endowment, but is very responsive to training and therefore is hard to test, because only individuals with equal training in any subject can be fairly tested and compared as to their native capacity to handle that subject Thus it becomes hard to contrive a test for musical or mathematical or mechanical endowment which could fairly be applied to races having diverse trainings in these lines. This difficulty, moreover, infects our tests for such general powers as memory or reasoning, for a test has to deal with some sort of material, and success in passing the test depends on the familiarity of the material as well as on the power of mind which we design to test We may suppose, indeed, that all of our tests, founded as they are on material which is familiar to us will be more or less unfair to peoples of very different cultures and modes of life The results of our tests need to be discounted somewhat —exactly how much we cannot say—in favor of the primitive peoples tested

The production of pig iron in Belgium in 1909 amounted to 1,632,000 metric tons, of which 1,386,800 tons was Bessemer and basic iron, 89,000 tons foundry iron and 156,590 tons forge iron The exports of pig iron were 19,000 tons and the imports 477,000 tons The imports of iron ore into Belgium in 1909 were 4 383 892 tons, as against 3,342 404 tons in 1908, practically all pig iron being made from imported ore

SCIENCE NOTES.

An impression has been widely circulated throughout the country that a considerable portion of the collections made by the Smithsonian African Expedition under the direction of Col Theodore Roosevelt will be distributed among the museums of the country Before the expedition started, it was understood that the collections should be largely limited to such material as was needed for a full exhibition and study series for the United States National Museum. This would include the collecting of a number of specimens of each animal, in order that the characteristics of each species would be represented It will not be possible to break up these series, as it would greatly diminish the value of the collection. The skins of the large game animals are now being prepared for permanent preservation, and will soon be in shape for study and comparison Arrangements are also being made to mount a portion of them for exhibition to the public.

The chemical behavior of the elements indicates that their energy content is very great, and it is probable that the matter of an atom is in a state of continual movement This subject is considered by N N Beketov in an attempt to explain the properties of radium We learn that although in general the atoms represent very stable systems, yet this internal energy may be the cause of their decomposition, as is the case with radium. In the various series of elements, increase of atomic weight is accompanied by increase of the atomic energy, and this increase is especially great if the atomic volume increases at the same time, consequently elements with high atomic volumes are extremely reactive. The atomic energy is probably composed of the real chemical energy—which becomes apparent in chemical reactions—and of the energy of movement of the smallest particles composing each atom On decomposition of the atoms, this energy of movement is converted into other forms of energy, as is observed in the case of radium

In an article published in the Phys Zeitschr, V J Laine states that on August 3rd, 1908, he observed during a thunderstorm a well-defined primary rainbow together with a secondary bow. The bows were continuous from one horizon to the other and whenever a peal of thunder was heard it was noticed that the colors of the primary, and especially of the secondary bow were strongly affected, and also that the color boundaries and the edges of the bows were quite effaced. At the same time the different colors were very indistinct, and the whole rainbow oscillated very quickly This happened every time it thundered That the effect was due to the thunder and not to the lightning was seen from the fact that the time between the observation of a flash and the hearing of the thunder was from 20 to 5 sec, and during this time the phenomenon was not observed, but it began at almost the same instant that the thunder was first heard At first the primary bow was very bright, the red then disappeared almost entirely, and the violet showed a great increase in intensity Below the violet was a distinct dark space, especially marked in the case of the secondary bow, and below this was seen a small greenish violet secondary bow. Then the oscillation occurred, and various other color effects and peculiarities were noticed An explanation of the observed effects is to be found in the variation of the size of the drops in the rainbow, according to the theory of the rainbow given by J. M Pertner in his "Meteorologische Optik." From this it appears conclusive that the effect of the thunder is to increase the size of the raindrops. It is possible that the thunder peals cause two or more drops to coalesce.

TRADE NOTES AND FORMULÆ.

[The Editor of the Scientific American Supplement does not guarantee the following recipes. They are taken from so many diverse sources that to test each one would involve much experiment The formulæ are published largely by way of suggestion Chemicals vary so much that in many cases the proportions given must be changed to obtain the desired result.]

Böttger's Red Ink (indelible) consists of carmine rubbed down with solution of waterglass and diluted with solution of waterglass To be kept in tightly closed vessels.

Carmine Solution for Microscopic Purposes (according to Cuccati).—30 parts of the finest carmine and 100 parts of crystallized carbonate of soda are rubbed down, and with 750 parts of distilled water brought to a boil in a porcelain dish. When solution is completed, add carefully to the cooled fluid: 50 parts of alcohol, 50 parts of 20 per cent acetic acid, 20 parts chloral hydrate, and enough distilled water to bring the whole up to 1,000 parts.

Bouillon Soup Tablets.—Finely chopped meat, absolutely freed from fat, is boiled in a saucepan with a little water and some salt, until a sample taken out becomes a solid mass on cooling. The addition of 5 per cent of the weight of meat in gelatine, expedites the solidification. The fluid is poured hot into little tin molds, in which it solidifies into tablets These, like chocolate tablets, are wrapped in tin foil or paraffine paper.

Lemon Juice, to Preserve.—Take 25 fresh, medium-sized lemons and one orange, peel them thinly and macerate the peel, finely cut up, for about 6 hours with 1500 grammes of 96 per cent alcohol. Press the juice out of the lemons, without filtering it, mix it with the alcoholic extract and stand it aside for about 8 days, shaking it frequently. After filtration we shall obtain, as a rule, a clear fluid, in which about 0 1 gramme of vanilla may be dissolved. If the filtrate is not clear, add alcohol until it clears

Nickeled Cuts.—By means of a weak galvanic copper positive, a thin copper negative is produced This must be again coated with silver, i. e., just made white, or in any other manner the surface transformed into sulphate of silver or better still, iodide of silver This negative is then suspended in a quick-acting nickel bath and a very thin coating of nickel deposited on it Now place the cut in a copper bath and reinforce it with copper to the desired thickness. The positive thus obtained can readily be separated from the negative, and is finished up as usual By this means, we obtain an absolutely sharp cut, the upper stratum of which, of any desired thickness, is nickel. Such plates will stand the largest editions and are not sensitive to color

Paper for Artificial Flowers (Bianchi patent)—Chinese rice paper (papyrifera) is placed for 1½ to 2 hours in the following solution: A pulverized mixture of about 125 parts saltpeter, 125 parts alum, and 125 parts carbonate of potash is put into about 3,750 parts of distilled or rain water, thoroughly stirring it; then boil the whole for a half hour, allow it to stand until the solution has cooled to about blood heat, then filter it through muslin. To the clear fluid thus obtained, we add, in this warm condition, 8 teaspoonfuls of wood alcohol and about 30 parts of pure glycerine When the rice paper has lain for about 1½ to 2 hours in this solution allow it to drain, and before it dries gently press out the superfluous fluid with the hands. Spread out in separated sheets in a warm, dry place for about two hours; it can then be colored. It is advisable to mix the colors with a small addition of wood alcohol and glycerine; for about 3,750 parts of coloring matter, about 375 parts of alcohol, and 375 parts of glycerine. The color is to be squeezed gently out of the paper, which is then spread out in separated sheets and again dried for two hours in the shade. By means of stamps or by other methods they are given the proper shape. The flower parts, or leaves, are lightly immersed in melted ordinary beeswax, rolled between the fingers and otherwise treated in the ordinary manner.

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Professor of Mathematics, Brown University

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A FRIEND of the Scientific American's donated a prize of $500.00 for the best simply-worded non-mathematical explanation of the Fourth Dimension. The prize was won by Lieut.-Col. G. D. Fitch, U. S. A This essay, together with three others which were awarded honorable mention, was published in the columns of the Scientific American As a result, so much interest was aroused in the subject of the Fourth Dimension that it seemed advisable to collect, in permanent form, the more meritorious of the 245 essays which were sent in from all parts of the world.

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USA

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* Abstract from an address delivered before the American Association for the Advancement of Science

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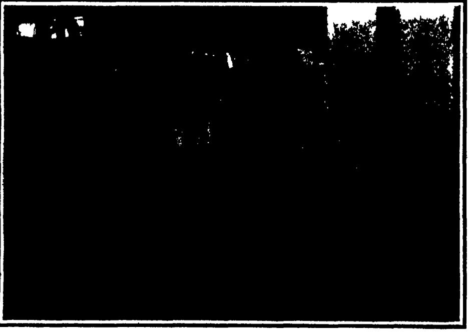
REELING SILK FROM THE COCOON

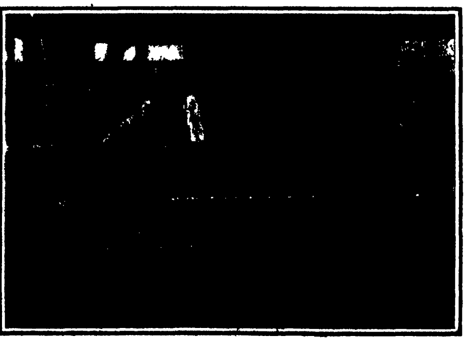
XAMINING SILK AND REMOVING IMPERFECTIONS

SOFT SILK WINDING



WARPING

QUILL WINDING



REAR OF BOX LOOM WEAVING FOUR COLORED CHECK. THIS HARNESS CARRIES 7,378 THREADS

BOILER CORROSION.

A STUDY OF ELECTRO-CHEMICAL ACTION.

It is somewhat disappointing, says Engineering, that with all our present scientific knowledge there are certain phenomena in connection with the corrosion of steam boilers which, though they are perfectly well known and very troublesome, are due to causes which are not clearly understood. Many explanations have been given, and yet little really seems to be known about them. There can be no doubt, however, that they are due either to chemical or electrical action, or probably to both. To what extent each of these is responsible for diseases such as pitting, wasting, grooving, etc., to which boilers are liable, has for long been a matter provocative of arguments and discussions. Volumes have been written on the subject, and numberless cures, some of them, to say the least, ridiculous, have been advocated and tried. The diseases, however, still continue, and in spite of all antidotes remain a constant source of worry to the owner and to the engineer in charge. The high temperatures and pressures now in use have also increased their importance. It is perhaps more than can be reasonably expected that any certain cure should be found for these evils, and all that we can hope for is that they may be mitigated. Enough is, of course, known to enable us to do this, but it still remains that boilers deteriorate from causes which in some cases are most obscure.

It is, we believe, held by some authorities of high standing that all kinds of corrosion of iron, in whatever form, may be put down to electrolysis, or, as it is more commonly known among engineers, galvanic action. We are not prepared to indorse this fully, although there is no doubt that many forms of corrosion arise largely, if not entirely, from minute electric currents which are set up between different parts of boilers when in contact with water. It does not appear, however, that our knowledge is yet sufficient to enable us to say definitely that purely chemical action is free from blame. It may prove to be so, but more evidence is needed before we can be sure on this point. There is nothing new in this theory of electrolytic action. For years it has been regarded as an enemy to boilers, and has been combated in many ways, and who among us with any experience of the working of boilers does not know how firm is the faith of some men that plates of zinc attached by various ingenious methods inside boilers are a sure charm against corrosion. The theory of the action of these plates may at times be very vague in the minds of the users, but the fact that the plates waste away is often held to be a guarantee that in so doing they save the boiler itself. This is no doubt frequently the case, but unfortunately, like many other so-called cures, zinc is not always successful. It is still quite possible, however, that electrolytic action has much to do with the corrosion of boilers. That it has escaped conviction is perhaps due to the difficulty there has been in obtaining absolute proof, though it has been easy to speak in a mysterious way of electric action when certain phenomena have puzzled us.

Now, in order to have electrolytic action, it is, of course, necessary to have an electro-chemical system. In steam boilers we frequently have it, for therein electrodes of differing potentials may easily exist, and may probably always do exist. For instance, in a locomotive boiler the shell may sometimes be the anode and the tubes the cathode, the water being the electrolyte, while under other conditions the reverse may be the case, the tubes being the anode and the shell the cathode, and it may take very little, a slight polarization possibly, to change the one into the other. The composition of the water also is an important factor. Probably in most boilers using ordinary water the iron of the boiler is the anode and therefore wastes away. By the introduction of zinc, which is electro-positive to iron, the latter may often be converted into the cathode element and be preserved at the expense of the zinc. The copper ferrule sometimes introduced between an iron tube and the tube plate at once introduces a voltaic couple, the iron tube in this case forming the anode and becoming the victim of electrolytic action, which takes place in the form of grooving near the ferrule or in pitting along the tube. A particle of carbon or cinder in the iron, which is electro-negative to that metal, may also set up this action, again at the expense of the iron, the result being the small pit holes so often found where corrosion is in progress. It does not, however, appear to be necessary to assume the existence of two elements within a boiler; couples may be set up by the iron itself, for they may easily exist, particularly in the commercial form of that metal, and in the conditions accompanying its use. Previous physical treatment, internal strains, and inequality of temperature are probably quite sufficient to account for electrolytic action.

Bearing upon this subject, a number of very interesting experiments have recently been carried out by Prof. C. F. Burgess, of the University of Wisconsin, with the object of ascertaining whether similar corrosive results to those found in actual boilers could be produced by means of minute electric currents in a laboratory apparatus. The experiments were made with a small model boiler, means being employed to measure accurately the magnitude of any small currents that might be set up. The apparatus used consisted of an iron pipe 17 inches long by 7 inches in diameter, which had its ends closed by screwed caps, in each of which there was a hole provided with a stuffing-box, the holes being placed somewhat below the centers of the caps. These stuffing-boxes were provided so that an inner iron flue tube 1¾ inches in diameter, which was passed through the caps, could be insulated from the shell, and at the same time allow the joint to withstand a pressure of about 100 pounds per square inch. Asbestos packing was found to be most suitable for this purpose. On the upper part of the shell a steam gage was fitted and a small cock for the release of the pressure, also a cock for the introduction of water. At the bottom of the shell was another cock for drawing off the water and sediment. A blast flame inside the flue tube was used as a means of applying heat. Between the inside and the outside tubes electrical connections were made through electrical measuring instruments, consisting of a milammeter and a millivoltmeter. A large number of tests were carried out with this apparatus, the boiler being charged with different kinds of water, while various conditions as to heating and cleanness were employed. Prior to each run or series of runs on a given water the interior of the boiler was thoroughly cleaned, after which 6,000 cubic centimeters (366 cubic inches) of water were introduced, allowing a steam space of about 2,000 cubic centimeters (122 cubic inches).

The tests showed curious results, particularly with regard to the variations of the electric current, these variations being in some cases somewhat unaccountable. In the first test referred to distilled water was used, and to this was added 3 grammes (9.27 drams) of amidol, the resulting solution being about 6,000 cubic centimeters (366 cubic inches) in amount. In all the experiments in which distilled water was used the water was produced under conditions that cause aeration, and air in boiler water is usually regarded as an important factor, though to what extent it is deleterious is not very accurately known. As soon as the water was introduced (at ordinary temperature) it was noticed that the current suddenly rose to 0.075 ampere, but the flow was only momentary, and continued only for a few minutes, decreasing rapidly at first and then more slowly, till at the end of 260 minutes it was only 0.0085 ampere. What the cause of this was does not appear to be very clear, but Prof. Burgess thinks that it may have been due partly to polarization effect both at the anode and at the cathode. This may possibly have accounted for it. The differences in the composition or previous treatment of the iron forming the inner and the outer tube respectively might, as he suggests, have been sufficient to cause the initial electromotive force which caused the current, while gradual polarization may have caused the decrease of the current that was noted.

When heat was applied to the inner tube after the lapse of 260 minutes, the current again rose to a maximum of 0.067 ampere, which point was reached somewhat before the maximum steam pressure of 100 pounds per square inch was attained. This latter occurred about 06 minutes after the commencement of the test. From this point there was at first a rapid decrease in the current, which drop, however, soon became slower, and at the expiration of 440 minutes, when the source of heat was removed, it had fallen to just below 0.015 ampere. At this point a rather curious thing was noticed. When the heat was removed the current suddenly made a slight jump up, but at once fell off rapidly till it reached almost zero. This sudden jump in the current when the heat was shut off was in fact noticed during many of the experiments, independent of the kind of water contained in the boiler. The jump, however, was not always a sudden rise and then a drop, but sometimes a sudden drop and then a rise. As before stated, different kinds of water were used, in some cases the boiler being filled with pure distilled water, while different substances, such as pyrogallic acid, hydrogen peroxide, soda ash, and barium hydrate were introduced in small quantities, the soda ash in the proportion of about 1 pound per 1,000 gallons. In this case the effect of the soda was to increase the conductivity of the electrolyte and to increase the current flow, which amounted at the maximum to about 0.044 ampere. This was considerably more than was noticed when distilled water was used. The voltage also was higher, reaching a maximum of about 0.100. With distilled water the maximum voltage was about 0.061.

A noticeable feature of the tests was that variations of pressure have little or no effect on electrolytic action, whereas temperature appears to influence the amount of current generated to a marked degree, and this was particularly observable in the case where soda ash was introduced into the water. If this chemical was employed in considerable quantities, it was found that the heated flue tube became the cathode element and the boiler shell the anode, and we believe that in actual practice this has been found to be the case, the shell being attacked by corrosion and the tubes remaining free from it.

In order to test the apparatus under conditions as nearly as possible akin to actual practice, trials were made in which, after the boiler had been tested, it was allowed to cool down and stand for sixteen hours short-circuited, after which it was again tested while still containing the water supplied to it for the previous experiment. On being heated up again the current was found to be smaller than on the previous run, and on being cooled down again and once more heated the current was smaller still. In another case, after the apparatus had been allowed to remain short-circuited for forty hours, heat was applied. During the first half of this test it was found that for 160 minutes the current curve showed the flue tube to be the cathode and the shell the anode, after which the opposite conditions existed, the flue tube being the anode and the shell the cathode, although the current was much smaller than before. About 120 minutes after the commencement of the test the heat was removed and the steam pressure was allowed to fall off, though the apparatus was not permitted to become cold. In about 315 minutes from the commencement heat was again applied, and the current quickly fell to zero, and was then reversed, the flue tube becoming once more the cathode. On the heat being again removed the current fell to zero. As to the corrosion that was noticed as a result of most of the tests, that on the flue tube was found to be similar to the corrosion found in locomotive boiler tubes, incipient pitting being noticeable along the tubes, especially in the lower portion. At the ends of the tube a marked pitting was also found.

Without referring further to the many tests described, some of the facts which they appear to have demonstrated are well worthy of attention. Of course it may be said that the working of the small apparatus does not constitute sufficient ground on which to form a trustworthy conclusion as to what really takes place in large boilers. To take up this position, however, would, we think, be unwise. Much valuable information is often gained from such small experimental appliances, and at any rate the experiments we have described are worthy of very careful attention and of extended repetition. They at least demonstrate the possibility of marked electrolytic action. They also show that repeated heating and cooling promotes corrosion, which is also greatly influenced by the quality of the water and scale-preventing compounds used. Now if differences of temperature are responsible for a large portion of boiler corrosion, as the experiments seem to show, the problem would be largely an electrical one. How is this electrolytic action to be prevented? Largely, no doubt, by the use of pure water, but not altogether, because so long as the water is a conductor so long shall we have electric currents formed unless some other means can be found of preventing them. Even distilled water has some conductivity. If it were possible to prevent the heated parts of a boiler from making metallic contact with those parts that are not heated, a cure for corrosion might be found, but there seems to be no prospect of this. Under existing conditions it is doubtful whether anything more can be done than a reduction of electric currents to a minimum by careful attention to the composition of the water, and the experiments which we have discussed show that a certain amount of control can be introduced in this way, even to the reversal of the currents. Again, and this is a point to which Prof. Burgess calls attention, it may be possible so to distribute the electro-motive forces that the electric current is made to flow in such a direction that the more vital parts of the boiler may be protected. This has, of course, been done by the use of zinc; but this metal being rather costly, many boiler owners are reluctant to use it. The oxide formed by the decomposition of the zinc is also said to be an objection on account of its harmful effects as a scale-forming material. As a substitute it has been suggested to employ some other anode which will not have the disadvantages of zinc, such as an iron bar made to take the place of one of the tubes in a locomotive boiler, and insulated from the rest of the boiler by some form of packing This bar could be made to act as the anode by means of an electric current passing through it from some external source and would therefore corrode in preference to the other part of the boiler It might be quite possible to try this method as the expense would not be great

In conclusion we may say that valuable as we consider the experiments quoted they form but a step on the threshold of the subject and much must yet be done before there can be any feeling of certainty with regard to the electrolytic forces at work within a boiler Prof Burgess has shown clearly that such forces produce the forms of corrosion met with there, but he or some other worker has yet to discover where the sources of these electromotive forces are actually located When this is done and not till then there may be some prospect of putting a stop almost entirely to boiler corrosion

THE STABILITY OF SHIPS.

SOME MISCONCEPTIONS CORRECTED.

There is often much loose thinking and more loose talking concerning the stability of ocean going steamers among those who ought to be better informed than the comments made sometimes seem to indicate There appears to be a feeling abroad that ships are being built with too much upper work too many decks and too much top hamper generally It would be idle to deny that the modern ship is developing more and more in that direction and that to the uninitiated appearances go against her A constant demand for elevated accommodation by those passengers able to afford the luxury creates a corresponding supply and the shipbuilder finds no difficulty in providing palatial structures of superimposed decks and tiers of cabins to satisfy it

The result is often that such a ship be she ever so handsome has what is called a topheavy look The word topheavy is a loose term to which we take exception Topheaviness if we understand it to mean either a lack of initial stability or a deficiency in range of righting power is not a question of height of ship out of the water only A ship may be dangerously near instability in the upright condition with little or no height of upper works and a certain height of freeboard is an absolute necessity if she is to have any range of righting power So then we must look to all the conditions which combine to produce the state of balance usually termed the condition of stability before founding a judgment as to a ships qualities in this connection

For convenience of thought we may assume a fixed displacement and draught of water i e that of the ship in her loaded condition For this there is a fixed height of transverse center of buoyancy depending upon the vertical distribution of the displacement It is in fact the position of the center of gravity of a homogeneous body of exactly the same shape as the immersed portion of the ship

The height of the metacenter above the center of buoyancy for all moderate angles of heel is also a definite quantity depending upon the form of the vessel and it is readily calculable For a fixed displacement and draught which we have assumed it is dependent wholly on the mean breadth of the water plane These two factors then are quite definite and the ship designer has no difficulty in knowing accurately their values The actual power of the vessel to return to the upright when forcibly displaced from that position however depends upon the height of the metacenter above the center of gravity of the ship and not primarily upon its height above the center of buoyancy Here we are confronted with a less determinate quantity The position of the metacenter relatively to any datum line say the keel of the ship is known from its height above the center of buoyancy but we must know also the position of the center of gravity of the ship relatively to the same datum line before we can find the relative positions of the metacenter and the center of gravity or the metacentric height as it is called upon which the stability qualities of the vessel depend

For war vessels and for fast passenger ships carrying little or no cargo the position is not difficult to estimate within quite small limits during the evolution of the design In these provided always that there be no serious change of disposition of weights the final stability values for small angles of heel may be closely approximated to The question of range of stability—meaning by this the possession of a force tending to return the ship to the upright—involves a longer process of calculation but is just as definite In warships with very low freeboard the range of stability may be comparatively small even with a good initial stability but in ocean liners the tall side gives a rapidly increasing righting power up to large angles of heel This assumes that ports and sidelights are closed, all immersed parts watertight and no weights shifted on board In these cases then, it is usually sufficient to ensure ample initial stability knowing that this quantity rapidly increases with heeling

From these considerations it will be seen that there should be no occasion for nervousness on the part of the traveling public, even where vessels have large numbers of superimposed decks, giving an appearance of top heaviness All the stability values should be known by the designer and the same amount of righting power provided on a ship having many decks as in one having few

There is an added consideration however in the former case which does not hold in the latter namely the upsetting effect of a heavy wind blowing on one side of the high ship and possibly blowing against the under sides of shelter and boat decks It must be remembered also that passengers are not only high up but that they usually all go to the leeward side when a beam wind is blowing There is the further consideration also of the momentum which high superstructures have when the ship is rolling in a heavy seaway The effect of position of passengers can be calculated and allowed for Wind pressure and momentum are somewhat indeterminate but naturally a ship designer makes ample allowance for these in fixing the metacentric height necessary for his ship Experience has shown that for liners such as we are considering this should not be much less than 12 in but for excursion steamers in which the number of passengers is large and their tendency is to go as high as possible and often all to one side the height may need to be 3 ft or 4 ft

But it is asked why not make the breadth of the liner a little greater and so increase her metacentric height also and obtain a margin of safety which will satisfy even the most timorous? That indeed is just the problem the designer of seagoing ships has to face He is always between the Scylla and Charybdis of too little or too much metacentric height Assuming that he has a free hand as to breadth of ship which is not often the case it would be fatal to the comfort of a passenger liner to give her too much initial stability for that means a violent return to the upright at every heel caused by the waves and consequently quick heavy and even dangerous rolling A ship to have seakindliness must have only a moderate metacentric height and in the cases mentioned this is easily determinable before hand from past experience To make quite sure most shipbuilders make a test of the initial stability of every ship after completion by moving known weights across the deck a known distance and noting the inclination of the ship produced thereby From this the righting moment is directly deducible and the position of the center of gravity can be verified There should therefore be no difficulty nor doubt in such a case as this whether the ship have a top heavy appearance or not

The case for cargo steamers and for those which carry passengers and a very considerable amount of cargo is on a different basis Here the problem is largely one of stowage It is obvious that a ship carrying a certain deadweight may have that deadweight consisting of materials of varying density and consequently the position of the center of gravity of ship and cargo in the loaded condition is a variable The general rule is to calculate the metacentric height when the holds are stowed full of a homogeneous cargo and the coal and consumable stores are out of the ship It is evident that if the stevedore has ordinary ability and freedom of action this will always be the worst position that is the center of gravity will be at its highest and consequently the metacentric height least If a fair allowance be made in this condition for initial stability a ship of ordinary proportions should be absolutely safe as far as stability values are concerned The question then becomes—how much latitude must one allow for want of knowledge or care on the part of those responsible for lading and working the ship? What are the possible contingencies that may occur? If for instance part of the cargo be of great density such as lead pig iron or rails and for some real or imaginary reason this weight be stowed in a higher position than it should be we have at once a condition not allowed for in the calculations and a consequent reduction of righting moment Suppose again that the ship be fitted with tween deck bunkers and the lower bunkers be emptied of coal before the upper ones are trimmed down into the lower position we have a state of matters tending in the same direction A ship so laden might be found to have a tendency to roll to one side or the other It is possible that the captain noticing this would to improve matters order ballast tanks to be filled During the process of filling quite a considerable time must lapse during which there would be a free surface of water in the tanks and this would temporarily add to the danger although when the tanks were quite filled the righting moment would be increased To obviate this most modern ships of large size have ballast tanks which are divided longitudinally at the center line of the ship by a vertical watertight keel plate and care is taken to fill only one or two tanks at a time

In ships of well deck type there is always a chance when rolling of shipping a heavy sea in the well Such an influx is not immediately got rid of and its weight would temporarily militate against the stability of the vessel Of course if by any chance a ship should get water into the holds or bilges through hatches or other openings such free water would act detrimentally in the same direction even if the quantity were inconsiderable as regards buoyancy

It will be seen then that the safety of ocean going steamers which carry cargo from stability considerations alone is more a question of management than design and that given a knowledge of the qualities of any particular vessel with care in lading and handling she should always be absolutely safe for the designer will have allowed an ample margin of metacentric height for the service upon which she is engaged from his accumulated data of other ships whose record has been good

The general public is naturally uneasy when a large vessel with many passengers disappears absolutely and leaves no trace but that is no sufficient reason for at once dubbing the ship topheavy and blaming the design as being unsafe on the assumption that the cause of loss is what is popularly known as turning turtle

The late Professor Elgar once said It often diverts attention from the main cause of loss to say that it occurred because the ship was unstable The fact is that the ship has frequently so little to do with the matter and the stowage so much that it is the latter which should be blamed for the instability and not the ship herself

While that is perfectly true it will probably do little or nothing to allay any uneasy feeling which may exist At the same time it narrows the issue considerably to have a correct conception of the probabilities of any particular or suspected case of instability which may occur

The plain procedure for owners is to have a full knowledge of the qualities of every vessel owned by them and to lay down certain rules as to stowage of cargo with respect to position of center of gravity when fully laden which may not on any consideration be departed from

This is of course more easily said than done for where large cargoes of mixed commodities have to be securely stowed by a fixed sailing date and the stevedore has to deal with many ships there is always a tendency to stow carelessly and to give scant attention to the exact position of the center of weight The captain of each vessel should however be the responsible man for that vessel and surely a simple instruction could be given to him which should be within his grasp and enable him to satisfy himself before sailing that the metacentric height is ample for all emergencies The Engineer

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In the first charge of a new ignition accumulator be not properly carried out its efficiency may be permanently impaired Acid should be purest brimstone sulphuric diluted to s g 1 225 with distilled water The acid should be added to water and not water to acid and the mixture should be allowed to cool before filling the cell After the accumulator has been filled with acid it should be charged for at least thirty six hours at about half the rate given on the label If after thirty six hours the s g of acid does not reach 1 225 or over the charging should be continued until it does After the first six charges it improves the capacity of a cell to empty out the acid while fully charged—and refill with fresh acid of 1 2[illegible] s g

INTERESTING CAM CONSTRUCTIONS.

NOVEL MECHANICAL MOVEMENTS.

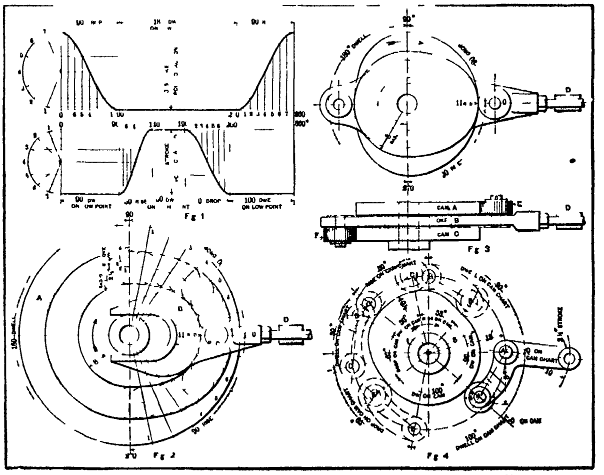
BY EDWARD PERSON.

When designing automatic machines that are more or less complicated, it is not always possible to avoid the use of cams in order to accomplish the work for which the machine is intended. When several cams are to be used on the same machine, it is necessary to make up a cam chart from which the designer works when laying out the cams. This chart should give the stroke required for the mechanism and indicate what part of the revolution of the cam shaft is required to produce the required stroke, as well as the period of rest. These quantities are given in degrees.

Fig. 1 shows a cam chart for two cams, the curves being crank motion curves. The first cam, starting at zero, moves the mechanism operated three inches while turning 90 degrees. It then has a rest or dwell for 180 degrees and a return movement in the remaining 90 degrees. The mechanism operated by the second cam rests until the cam has turned 90 degrees; the cam then imparts a motion of 2½ inches from 90 to 140 degrees. There is then a dwell for 50 degrees, a return motion during 70 degrees, and finally a 100 degree dwell on the low point of the cam.

The crank motion curves on the cam chart are constructed as follows: Set off the stroke of the mechanism, three inches in the first case and two and a half inches in the second. Construct a half circle with the length of the stroke as diameter and divide the half circle into a certain number of equal parts. Also divide the length representing the drop and rise into the same number of equal parts as that into which the half circle has been divided. Then draw lines from the dividing points as shown in Fig. 1. The intersecting points will be the points of the curve. It is of importance that these curves be correctly constructed, as this provides for a smooth movement of the mechanism at any point during the revolution of the cam. Of course, these curves do not need to be crank motion curves, but can be changed to suit conditions.

Figs. 2 and 3 show the constructions of cams laid out from the first cam chart curve in Fig. 1. These cams are working positively in either direction. The construction in Fig. 2 consists of a grooved cam *A* and a yoke *B* forked over the hub of the cam and carrying the roller *C* placed in the groove. When revolving the shaft, the yoke, guided by a bushing at *D*, will move back and forth three inches in a straight line. For laying out the cam proceed as follows: Set off from the zero point on the cam in a direction opposite to that in which the cam revolves 90 degrees, and from this point set off 180 degrees and then another 90 degrees, which brings us back to the starting point. Determine the highest and lowest points on the cam, which in this case are located 8 and 11 inches from the center respectively. Set off at the lowest point (as shown at the top of the cam in Fig. 2) the radius of the roller and the stroke of the cam, which latter of course is the same as the difference between the highest and lowest points. Draw a half circle having the stroke for its diameter, as shown, divide the circumference of the half circle into the given number of equal parts, and draw perpendiculars from the division points to the diameter or base line. Then divide the angles for the rise and the drop into the same number of divisions as that of the half circle and draw radii to the division points from the center of the cam. From the points where the perpendiculars intersect the base line draw circular arcs with the center of the cam shaft as a center until the arcs intersect the corresponding angular division lines. Take the points of intersection for centers and draw circles having a diameter equal to the roller diameter. The line tangent to these circles is the true crank motion curve.



CAM CHARTS AND DIFFERENT METHODS OF LAYING OUT CAMS.

The second cam construction, Fig. 3, consists of two cams *A* and *C*, one on each side of the yoke *B*, and two rollers *F* and *F* mounted on each side of the yoke. The yoke in this case is also forked over the hub of the cams and guided at *D*. The cam curve for the top cam is identical with the inner curve in Fig. 2 and is laid out in the same manner, as is also the rise and the drop for the bottom cam. The only difference is that when the top cam has a dwell on the high point the bottom cam has a dwell on the low point, and *vice versa*. This of course insures a positive movement both ways.

Fig. 4 shows another cam construction laid out from the second chart in Fig. 1. It consists of only one cam, a lever and a roller. This construction is positive only one way and must be actuated by a spring for returning, but it can be arranged to work positively by making a three-arm lever, a return cam and a return cam roller. The point illustrated in Fig. 4 is the variation of the angles of the cam as compared with those of the cam charts due to the rise and the drop of the roller on the end of its lever. Instead of turning the cam shaft in the direction indicated by the arrow, assume that we swing the center of the lever pivot in a circle around the center of the cam, but in the opposite direction to the cam motion. To lay out the cam, we must first assume the length of the lever, the stroke of the cam, and the highest and the lowest points on it. The center of the lever pivot at the start will be at zero on the cam chart, and the center of the roller will be at zero on the cam. From the zero of the lever pivot, Fig. 4, set off 90 degrees for the dwell on the low point, 50 degrees for the rise, 50 degrees for the dwell on the high point, 70 degrees for the drop, and then 100 degrees for another dwell on the low point. Draw radii from the center of the cam shaft to each of these divisions. Take the points where these radii intersect the circle along which the center of the lever pivot moves as centers for circular arcs having the roller arm *AA* for radius, as shown at *BB*, *CC*, *DD* and *FF'*. Then set off from the center of the cam shaft a distance equal to the radius of the cam plus the radius of the cam roller at each of these places (at *B* the distance set off would be 8 + 2½, at *C* 10½ + 2½, etc.). The points of intersection between these distances and the arcs struck with radii *BB*, *CC*, etc., are used for centers for circles having a diameter equal to that of the cam roller. Now it will be seen by measuring with a protractor that where the dwell occurs the angle of the cam will be the same as the angle on the cam chart, but where a rise or a drop takes place the angles will be different. In the present case the 50 degree rise on the cam chart and of the cam lever will be about 53 degrees on the cam, and the 70 degrees drop on the cam chart will be about 67 degrees on the cam. This is of importance when several movements are used and one movement starts immediately after another in such a relation that one must come to rest before another starts. The curves for the cam can be laid out in a manner similar to that explained in Fig. 2.—*Machinery*.

BLOWPIPE METHOD FOR CUTTING IRON OR STEEL.

The oxyhydrogen blowpipe process for cutting iron or steel is coming into use on an extensive scale in various countries of Europe. The following recent data will show some of the advantages which are obtained by its use in the way of time and expense. An armor plate of 160 millimeters (6.3 inches) thickness is cut for a length of 1 meter (39.37 inches) in 10 minutes. For the same length the cutting of a 15 millimeter (0.59 inch) plate requires less than 5 minutes, and the cost of the operation is not over 1.50 franc ($0.30). To cut a manhole of 300 by 400 millimeters (12 by 16 inches) in a steel plate of 20 to 30 millimeters (0.8 to 1.2 inch) requires 4 or 5 minutes. A 6 by 16-inch hole for tubulure cut in a pipe of 0.2 inch thickness takes from 3 to 4 minutes, while the usual method of cutting requires from 35 to 40 minutes. The expense by the blowpipe method is from 2 to 3 cents. An interesting example of blowpipe work was carried on in Paris at the Metropolitan subway station Place d'Italie. It was required to cut away an iron staircase of 6 meters (19.7 feet) height and to decrease the width, as the present width of 3.50 meters (11 feet 5 inches) hindered the circulation. Accordingly it was decided to cut off about 3 feet width of the whole staircase, and this was done within four hours time. The small portion which had been cut off was also used as a staircase in another place and was in no way damaged by the operation. At the shops of the Northern Railroad Company there were cut out certain portions of the main longitudinal beams of a locomotive without dismounting the latter, and the cutting was done in two places. By the old methods this operation would have taken at least 3 days, but at present it was done in 25 minutes. The expense for the gas in this case was but $0.80. At Bremen, Germany, the new method has been used for demolishing vessels, and the following results were obtained: A steel plate of 300 millimeters (12 inches) thickness was cut for a length of 1 meter (39.37 inches) at a depth of cut equal to 4 to 6 centimeters (1.6 to 2.4 inches). This operation took 7 minutes. The same plate was cut by a pneumatic tool for 1.15 meter (3¾ feet) length and at a depth of only 1.5 centimeter (0.6 inch), and this took 1 hour to carry out. The blowpipe process was also useful for unriveting plates, and it was found that in less than 12 seconds it is possible to burn off the head of a 22-millimeter (0.9 inch) rivet without detriment to the plate. The rivet is then driven out by forcing. The greatest thickness of armor plate which has been cut up to the present is 210 millimeters (8.4 inches), but a thickness of 300 millimeters (12 inches) is reached in the case of round shafting. At the Lorient shipbuilding docks in France, holes are constantly cut of all forms in plating of 65 millimeters (2.6 inches) thickness, this plating being formed of three thicknesses riveted together, and is used for the decks of warships.

TUNNELS IN BEING AND TUNNELS TO COME.

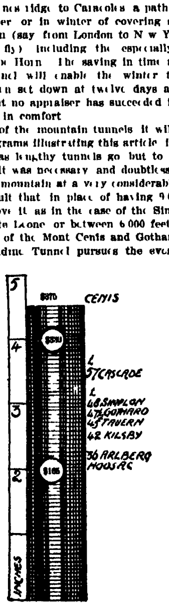
THE WORK OF THE BURROWING ENGINEER.

As NOVEMBER waned the last few yards of tunneling necessary to link the far eastern and remote western sections of the Buenos Ayres and Pacific Railway were duly excavated. The occasion was particularly noteworthy, not only on account of the fact that the task accomplished represented a feat remarkable in an age accustomed to marvels of engineering, but because the way was cleared for the passage of the first through train from the Atlantic to the Pacific coast of South America, a journey that should be completed for the first time during the current year.

The Trans Andine Tunnel, though not remarkable for its length (its two miles burrow is exceeded in linear measurement by ten tunnels in the United Kingdom alone), is distinguished, apart from its political importance, by the fact that the work was carried on at an elevation of 10,000 feet, which is of course 1,000 feet higher than Europe's most soaring carriage road, the Stelvio Pass, but rather more than 5,000 feet below the remarkable Galera Tunnel in Peru, whose drainage water runs from its eastern exit into the Atlantic Ocean, while that from the western mouth percolates downward until it mingles with the waters of the Pacific.

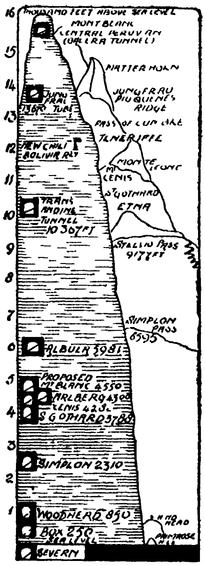
When the line is completed the traveler at Buenos Ayres desirous of reaching Valparaiso will have before him a railway journey practically coinciding in length with that between Calais and Rome, but rather more tedious, one would opine, from the fact that gradients of 8 per cent are encountered *en route*, entailing the use of the rack and pinion. Notwithstanding, however, the fact that the Trans American route will most probably take longer than the thirty-six hours that the Calais-Rome journey entails, there is no doubt that the traveler will face the journey this year with far greater equanimity than in the pre-tunnel days, when he had the prospect of either being detrained at Las Cuevas and having to cross on mules a spur of the Piuquenes ridge to Caracoles, a path only open in the summer, or in winter of covering some 3,600 miles of ocean (say from London to New York as the aviator will fly), including the especially troubled waters of Cape Horn. The saving in time and money that the tunnel will enable the winter traveler to make has been set down at twelve days and £13 respectively, but no appraiser has succeeded in estimating the gain in comfort.

The latest of the mountain tunnels, it will be noted from the diagrams illustrating this article, is comparatively short as lengthy tunnels go, but to attain this desideratum it was necessary, and doubtless desirable, to pierce the mountain at a very considerable altitude, with the result that in place of having 9,000 feet of mountain above it, as in the case of the Simplon Tunnel and Monte Leone, or between 6,000 feet and 7,000 feet in those of the Mont Cenis and Gothard tunnels, the Trans Andine Tunnel pursues the even tenor of its way about 2,300 feet below the pass of Cumbre, which crosses the Argentine-Chili frontier at an altitude of 700 feet above the highest level to be attained by the new Arica (Chili) La Paz (Bolivia) Railway, whose 300 miles or so of permanent way the well-known firm of contractors, Messrs. Sir John Jackson, Ltd., have now in hand.



THE COST OF SOME WELL KNOWN TUNNELS PER FOOT IN DOLLARS.

It has been put on record that the actual sum voted for the railway that is to join up "the highest city" in the world, La Paz, 12,000 feet (Sicuani, 14,666 feet, on the Southern Railway of Peru, cannot apparently claim the rank of city), with the Pacific coast, is £3,000,000. If this amount represents the total contemplated outlay on a railway of 300 miles, a startling awakening would appear to be in store for the promoters of the scheme, judging from the figures provided by mountaineering railways on this side of the Atlantic. For instance, the most recently opened European railway, the Tauern system, formally inaugurated by the Emperor Francis Joseph last summer, which runs from Gastein in Salzburg to Spittal on the Drave (Carinthia), though only some thirty miles in length, cost twelve and a half million sterling to build, of which amount the great Tauern Tunnel near Gastein, that took nearly eight years to build and is 5¼ miles in length, accounted for one and a quarter millions sterling.



SOME ELEVATED TUNNELS

Tunnels are very expensive luxuries even in the present year of grace, but they are nothing like so expensive as in the days of the Cenis excavation, when each yard linear cost $1,130, and the total cost was just about ten times the sum ($1,400,000) expended in the early years of the last century in making the road over the Simplon, a task that only occupied five years, notwithstanding the fact that 1,722 feet of rocky galleries had to be blasted and 250 tons of gunpowder (as compared with 157 tons in the case of the Woodhead Tunnel, Great Central Railway) used for that purpose. The famous Simplon Tunnel that occupied so much attention on its completion early in 190[illegible] cost all told $720 a yard, a statement that can best be appreciated when it is realized that on some occasions there were 4,000 men working on it at once (the Trans Andine authorities were content to employ half that number), that the bore holes numbered 4,000,000, the explosion caps a like number, the fuses aggregated 3,290 miles, or enough fuse to extend from Liverpool to New York, while for the purpose of dislodging 35,314,800 cubic feet of *débris*, sufficient to cover a road 60 feet wide to a depth of 1 foot through 109 miles (London to Bath), 1,350 tons of dynamite had to be exploded.

At periodic intervals rumor asserts that the mighty Mont Blanc herself is to have a tunnel driven through her majestic proportions for the purpose of linking Chamounix and Aosta, but up to the present date nothing has been done with respect to the scheme in question, apart from the preparation of M. Jacquier's plans, which indicate that the excavation would be 8¼ miles in length, that the entrance at Chamounix would be 3,41[illegible] feet above sea level and the exit at Entrèves [illegible] feet higher still.

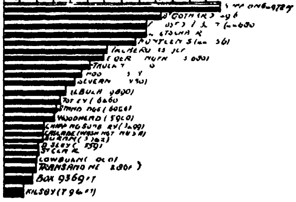
Not a hundred miles from Chamounix (fifty-five in point of fact), however, yet another lengthy tunnel is now being made that, unless its name is changed for something with fewer possibilities in the way of pronunciation, is scarcely likely to attain conversational popularity in circles addicted to using the English tongue. The Loetschberg, to give it its local appellation, is to have as its terminus that singularly beautiful village Kandersteg at the foot of the Gemmi Pass, and the object of the tunnel and the line running through and in connection with it is to provide a short cut from Calais and the north *via* the Simplon to Italy in general and Brindisi in particular, the saving in distance over the present route being fifty-two miles.

The Loetschberg, which passes under the Balmhorn and might very well be named after it, on leaving Kandersteg burrows under the Kander River and eventually comes into the light of day in the Lotschenthal. It then dives into the mountain again for a few kilometers, and, bearing round to the right, emerges in the Rhone valley, on the north side of which, parallel to the Swiss Federal line, it proceeds to Brigue, where it joins the Simplon line.

In addition to the Jaman Tunnel on the Ligne Montreux-Oberland-Bernois, that has a length of 8,1[illegible] feet and an altitude ([illegible] feet) rather more elevated than the summit of Snowdon, and upon which £18,000 worth of dynamite was expended, within the last few years a tunnel has been pierced between Lichtensteig (sixteen miles southwest of St. Gall) and Utznach that is rather over five miles in length, while a number of other central European tunnels have been projected, of which that through the Col de la Faucille between Lons-le-Saulnier and Geneva is the most important.

To the motorist the Col de la Faucille is an eminence (4,300 feet) about seventeen miles from Geneva which, when attained by a 10 per cent rise, presents exquisite views of the Alps and Mont Blanc prior to a descent *en lacet* of 7 per cent to Gex; to the railway engineer, however, the Col presents a nut to crack which would necessitate expending £4,000,000 on a tunnel nine miles in length that would be about 1,831 feet above sea level and have a steepest grade of 1 in 160. The tunnel, it is estimated, would save 2½ hours on the journey between Paris and Switzerland, and would represent the first stage of the new and most direct route from England to Italy *via* Chamounix, Mont Blanc and Aosta, a route that would possess one great advantage from the Gallic point of view, inasmuch as it would mean that the traffic would practically pass through French territory and over French systems from start to finish.—The Car.

Eddy currents, or Foucault currents, as they are sometimes called in honor of the man who first explained and described them, are very difficult to calculate, because they occur in closed circuits of their own selection in the mass of a metal, and are not restricted to definite wires or simple channels. Of recent years, however, a number of practically important cases have been successfully analyzed mathematically. A very attractive solution for the case of copper strips in the grooves of a simple alternating current armature has recently been given by Dr. F. Rusch in Electrotechnik Maschinenbau.



COMPARATIVE LENGTHS OF SOME FAMOUS TUNNELS

THE GERMAN ARMY.*

ITS MERITS AND ITS DEFECTS.

BY RICHARD THIRSK.

The German army is composed of the combined armies of Prussia Bavaria and Saxony. Generally speaking it might as truthfully be called the Prussian army as nineteen of the army corps belong to Prussia whereas Bavaria has but three and Saxony only one. The total strength of these combined armies during times of peace is put down on paper at something over six hundred thousand officers and men divided into six hundred and twenty-nine battalions of infantry four hundred and ninety-five squadrons of horse five hundred and seventy-four batteries of field artillery forty battalions of fort artillery thirty-four battalions of engineers and sixteen machine-gun divisions. Besides these there are the various necessary auxiliaries for serving such a large army including the medical staff the commissariat the veterinary surgeons and other noncombative forces. A bill passed recently by the Reichstag empowers the authorities to augment largely the number of men serving in the ranks.

The term of service in foot regiments is for two years in the cavalry and horse artillery men must remain a year longer. From active service soldiers pass into the First Reserve for a period of five years during which they are frequently called up to their regiments for longer or shorter periods of drill. At the end of this time they pass into what is known as the Landwehr or Second Reserve and finally into the Third Reserve in which they remain until the completion of their thirty-ninth year when they are freed from military service.

While on active service the infantry soldier receives six shillings a month pay the cavalryman two shillings more. Lieutenants begin with sixty-four pounds ten shillings a year rising slowly through various grades to six hundred and ninety-nine pounds a year which is the sum paid to commanding general. To this must be added a small allowance for rent granted to officers who cannot be housed with their regiment.

The Kaiser is the Oberster Kriegsherr that is to say the supreme head of the army whose approval must be obtained in all that concerns it who controls all its movements and who alone has the right and power to send it into action. He has taken upon himself the responsibility of its efficiency and conduct and it is very possible that should he take it into action he may command it in person.

In his position as chief of the army the Kaiser is assisted by the military cabinet composed of a number of high military authorities whom the Kaiser elects as overseers of the various departments of the service and whose duty it is to report to His Majesty in council all that takes place in the German army and in the armies of foreign nations.

Next to this is the war office which is under the charge of the minister of war. The latter is a soldier of long and varied experience who also represents the army in the Reichstag answering the questions asked by deputies concerning it and negotiating in the Reichstag the yearly grants necessary for the maintenance of the army.

The war office is divided into a number of sub-offices each under the control of its own military chief who is subordinate to the war minister. From these offices instructions money provisions and all other necessaries are dispatched to the units in the barracks or in the field. Thus the whole organization meets under one roof which prevents any confusion or the possibility of one part working against another and constitutes the war office the great controlling house without which the army would fall to pieces.

But the organizing power the brain the eyes the ears the very soul of the army is the general staff. This is a colossal institution composed of only the picked men of the whole army those men who have distinguished themselves by their military genius their knowledge of tactics their capacity for organizing and inventing or by other distinguished qualities calculated to increase the efficiency and usefulness of the army. They are all of them men with ideas and of unquestionable ability devoting themselves entirely to the work of perfecting the complicated machine of which they are parts. The general staff is also the intelligence department and is responsible for all necessary information regarding the strength, movements guns arms and every conceivable particular concerning foreign armies forts defenses and the like. According to this information changes are made in the German army to cope with every emergency and plans for attack or defense are worked out. Basing its conjectures upon the information in its possession the general staff has considered every possible chance of an attack upon Germany from any quarter and has shown how such attacks are to be repulsed and how the enemy is to be driven back. Recognizing the possibility of an offensive campaign it has worked out on paper campaigns in foreign countries. Locked away in its secret safes the general staff has its plans prepared with the greatest mathematical exactness for the conquest of nearly every nation.

It is when one comes to know something of the general staff that one realizes what the German army really is and understands something of its magnitude. To discuss the possible success or failure of its plans and theories would be idle. The fact that these have been prepared and are kept constantly up to date is a proof of that spirit which courts success and of the determination of the nation to be ready for each and every emergency. All these plans and theories are tested from time to time in the light of recent events. Struggles between combating powers are watched by the general staff with the closest attention all the incidents marking their progress are impartially criticised and the lessons learned from these are applied in practice forming the groundwork for changes and improvements. Another equally important duty is to secure carefully prepared plans of all countries in which Germany may at any time be called upon to carry out military operations.

Probably the most serious work falling to the general staff is the arranging and preparing of secret plans for the mobilization of the army and reserves the moment war is declared. As a knowledge of these plans would be of incalculable service to a hostile army and as there is always the possibility that some part at least of the secret may be betrayed to some interested foreign power the plans have to be constantly changed and altered which means that the work on them is never ceasing. With what smoothness these plans work collecting the whole fighting army and transporting it to the scene of action together with all necessary munition and provisions was amply demonstrated during the Franco-German war of 1870-1. Then as now every general had his sealed orders and a time-table which it was only necessary for him to follow in order to arrive at the scene of action at the time he was expected. So well did these arrangements work out that though hundreds of units were involved in the various movements Moltke could calculate with certainty to within a few minutes upon the arrival or departure of any one of these units.

Today with increased railway facilities the system is even more perfect. Yet the railways have added to the complication of the task making it more difficult to get a comprehensive view of the perplexing network of lines throughout the country and the work of timing the arrival and departure of trains from all parts of the Empire and of managing everything so that no block can possibly happen drives many officers insane. This work in the time-table department is so dreaded that it is difficult to induce officers to take to it in spite of the increased social advantages which such a position on the general staff offers them.

This is as briefly as it may be told the composition and machinery of the army which was established by Frederick William I and developed by Frederick the Great into that powerful weapon which has helped to make the nation what it is to-day. Its history has been checkered and does not always justify the pride with which Germans boast of its deeds prior to its achievements in the war against France or even since then yet no one can gainsay that as a fighting machine it is as nearly perfect as human means and genius can make it. It certainly is a wonderful institution a marvel of ingenuity and organization a monument to the patience and skill of those who are responsible for its existence.

The motto of the German army is 'Ready' and that is the keynote of everything done in every department of it. A solid business-like spirit pervades everywhere and nothing that brains energy or money can suggest or do is spared nor anything left undone which may help to keep it true to its motto and be always 'ready.'

Unfortunately it is an axiom that there seldom is a good that has not its attendant evil, and German militarism is no exception, as the Germans themselves are the first to admit. One of these evils is its increasing cost to the nation but this must be looked upon as a necessary evil since the army is the symbol of settled security to which the nation owes its existence and endows it with that confidence so essential to industrial and commercial success.

Heavy as it is the cost of maintaining the army is not the heaviest part of the military burden. It is as nothing compared to the enormous sacrifices which universal military service demands and this hits hardest the middle or commercial classes whose sons must give up to the army some of the best years of their life which needless to say generally proves a severe handicap to them in the prosecution of their studies or the following of their commercial pursuits. The frequent claims which the army makes upon their time at varied periods cause a feeling of unrest and dissatisfaction. On this very practical point all the German's theoretical pride in the army vanishes. He complains that universal military service is a vicious unrelenting institution which makes no allowances or exceptions which never takes into consideration whether or not it is ruining a young man's chances in life. It is so far-reaching that it hinders and upsets the ordinary course of business. Merchants and manufacturers look upon it as a bugbear. Almost the first question they ask an applicant for a vacancy is if he has finished his military service and if he has not they prefer not to employ him. They complain that they no sooner have taught a young man their business methods and find him of use to them than he must leave them for the army and they cannot afford to let their business stand still until his return so they have to fill his place as best they can and when the young man leaves the service he is without a situation. No amount of argument can prove that it is a good thing to disturb the routine of a business either for employer or employed. Therefore however beneficial compulsory service may be for the nation it damages the individual. And the hardships do not cease on expiry of the first term of military service for when the reservist goes to exercise for eight weeks with his regiment either he and his family must suffer or his master.

When a man settles down in business for himself his case is even worse if possible for it has happened that the army has ruined many who had to begin in a small way. An instance of this was reported in the newspapers quite recently and it may be taken as typical of many though fortunately they are not all attended with the tragic circumstances which brought this case before the public. A man invested all his capital in a business to which he applied himself with diligence and began to do very well in it until he was called out to serve some weeks with the Reserve. Unfortunately for him he had not the means to afford a substitute to keep his business going during his absence. On his return he shot himself and the examination proved that his reason for doing so was because his business which depended entirely upon his personal effort was hopelessly ruined through his having to close it for so long a time.

Another objection to universal military service is that it is dangerous to health—not the actual service but the dread of it. Nearly all enterprising young men desire to escape military service for no other reason than that they wish to enter at once upon their lifework. In the hope of unfitting themselves for passing the doctor's examination they tamper with their health often causing such damage as to ruin it permanently.

It is because of universal military service that Germany has never been a successful colonizing power. The adventurous young men those who might be getting about the world and probably winning territory for the fatherland are obliged to stay at home for the army. If they do go away they must return within a certain time and at their own expense. This is seldom convenient or practical and compels them to choose the alternative either they must give up what prospects they have before them and become soldiers or they must throw off their allegiance to Germany entirely, becoming citizens of the country in which they have settled.

The present condition of Germany's colony in Southwest Africa is a startling revelation of the failure of conscripts as compared with volunteers, to keep law and order in a colony. In the disastrous campaign against the Hereros, Germany refused to employ men who lived in the country, who had their interests there, and who knew the ground, preferring conscripts from home, who went out feeling they were going to martyrdom. One way or another they managed to drag out the punitive expedition for an unconscionably long period, and few of them returned with much glory to themselves.

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* Chambers's Journal

Realizing some of the drawbacks of universal military service, the government has tried to minimize its hardships by introducing what is known as the Einjahrig Freiwilligedienst or one-year service. The privilege of serving for only one year instead of two is granted to all who pass the middle classes of a high school. For this privilege they have to pay all the costs out of their own pocket. These include kit, uniforms, board and lodging, a man-servant, and the numerous expenses incidental to a soldier's life, which in the crack regiments may run up to a thousand pounds for the year, and which in the so-called cheap provincial regiments average two hundred and fifty pounds. From these one-year service men are recruited the officers of the Reserve, and as this title carries with it much influence, most young men are ambitious to obtain it. But as a very large percentage of those who possess the necessary certificate have not sufficient money to pay their expenses, they are obliged to launch into debt, and to place themselves and their parents under obligations which burden hampers them in their future career. Hence many young men who have the one-year service qualification and not the necessary funds are obliged to serve as ordinary soldiers, for although the government has a fund for assisting such, the conditions under which it is granted are not particularly enticing.

Another objection to this favor shown to educated men is that one-year service men are not popular with the ranks, being considered the legitimate sport of all who can take advantage of them. Nor are they looked upon with much favor by drill instructors, except in those instances where there is a prospect of future gain. The drill instructor is generally more noted for his bullying and abusive proclivities than for his intelligence, and only too often uses the power confided in him to make the soldier's life unbearable. His idea of a soldier is that he is something like a wild animal, which must be trained to do a certain number of things in a certain way within a certain time. The authorities allow him considerable latitude as long as he produces the results required of him, though he has frequently to be court-martialed for the brutal and disgusting methods he adopts.

For a man of education and self-respect to submit himself to the rule of such a drill instructor is to feel degraded and insulted. Rather than undergo this treatment many young men leave the country never again to return to it, for the pains and penalties awaiting them in the event of their return are more terrible than the method of the army they flee from. The mere fact of their running away proves them in many cases to be young men of spirit and pluck, such men as the country cannot easily afford to lose, who, were they permitted to remain at home, would turn out useful members of society. As it is they look back upon the Fatherland with no particular pride, and their parents often curse the evil which robbed them of their sons, and when a son longs to return through illness in the family, or when other occasion requires his presence, he is kept away by fear of the authorities, who are waiting for him the minute he puts his foot upon German soil.

For this reason, it is to be feared that the army is killing patriotism in Germany, even in the army itself. The service is dreaded more and more as industrialism advances, and the only good thing that men have to say for it is that they have done with it. So strong is the feeling against it in the middle classes and the lower classes that were it not for universal military service very few men would be soldiers in Germany. Doubtless when the necessity arose volunteers in plenty would flock to the standard, but during peace-times the army is far from popular, and individual pride in it is more abstract than real or practical.

It may be possible that the conditions of life for which the army is responsible account for the sad fact that so many Germans when they go abroad deny their own country. It may also be for the same reason that they permit themselves so readily to become absorbed by other nations, making good citizens of other lands, to the abiding loss of their Fatherland. The greater freedom they enjoy abroad appeals to their imagination, they feel themselves more the masters of their fate, and they take advantage of every opportunity offered them by throwing off all their allegiance to the home-country and naturalising in the new.

Many complain that the army is an institution which the introduction of commercialism has antiquated, an institution that has not kept pace with the forward march of events. Much dissatisfaction is found in the army itself. The men complain that they have far too much drill and too many parades, that they have to go through exercises from sunrise till sundown, until they are completely worn out. There is also much grumbling about the food. It is of a kind to which many of them have not been accustomed at home, and which they say is no more than sufficient to keep up their strength. The coarse black bread they can hardly eat, and the pay they receive is not sufficient to keep them in tobacco. Consequently they are dependent upon their parents and friends to send them hampers of food and money. Their great longing is for the time when they will be able to return to civilian life, and they tick off on their calendars the days as they pass, anxiously counting the time that remains between them and liberty.

Even the officers have their grievances. They feel in all things the power of the one hand, as they express it, that the army is too much the Kaiser, being held in subjection to his absolute will. Every now and then he introduces changes in the officers' equipment or the style of their uniforms by way of experiment, the cost of which comes out of the pockets of the officers, who grumble about the expense. Officers are in no sense of the word free agents. Even their opinions are prescribed for them, and if they hold views on politics, government and progress which are known to be at variance with those held in high quarters, they are compelled to run the gauntlet and possibly to leave the army. They are forbidden to smoke in the three fashionable streets of Berlin, and if when they are driving they meet a royal equipage with the coachman holding his whip aloft, thereby denoting that some royal personage is behind him, the officers must stop their carriage, alight and stand at the salute until the royal equipage has passed by. No officer can marry without the consent of his superiors, who inquire if his intended wife is a fit associate, and should the result of the inquiry prove favorable, a fixed sum of money must be invested in the regimental funds, upon the interest of which the officer and his wife may be able to keep house and entertain in a manner befitting their position in the army.

Doubtless the sorest point of all among the officers is the slowness of promotion. Because of this many of them who are poor to begin with, and who have not the good fortune to marry money, have to eke out their salaries by remittances from home until they are over forty years of age. Usually an officer without influence serves something like twenty years before he obtains a captaincy, and before he can attain to any of the more lucrative positions he has reached the age limit and is retired on a pension wholly insufficient to keep him in comfort. It is stoutly maintained, and with some show of truth, that all the good posts in the army go to favorites belonging to the nobility, who practically hold a monopoly of such positions.

Much has been said in praise of the German army as being a good training ground for the rougher element of the population, instilling into it some notion of discipline and orderliness. This the army may do, but it is questionable if the good wrought in this way is in due proportion to the evil wrought in other ways—as for instance when a young man who has been carefully brought up at home enters the army and comes into contact with the evil influences of the questionable characters around him. Whether or not he submits to these is merely a question of temperament and character. The chances are that in the process of having his eyes opened he gets somewhat contaminated, and returns to his home a different man morally from what he was when he left it. In any case, it is not a particularly pleasant prospect for respectable parents to have the knowledge that their sons are likely to be boarded together with young men whose respectability is so questionable that the army contemplates reforming them.

Considering the large number of men serving with the colors there is comparatively little crime in the German army. The latest statistical report for the year 1907 gives the number of military and civil offences dealt with by the military authorities at ten thousand two hundred and fifty-three, and this proves a considerable decrease on the previous year. There are, however, a number of irregularities for which the army is either directly or indirectly responsible, but which are not included among the offences and are therefore not published in statistics. The army is more concerned about drill than about morals. Its one and only aim is to lick the soldier into proper shape so that he may fit exactly into his place in the machine. Its method of accomplishing this end is systematically to crush all individuality out of him and to make him one of the crowd, moving in blind obedience to the word of command. Hence officers will tell you that in a whole regiment they cannot find more than twenty or thirty men in whom they can place any confidence; and it is on those few that they must rely for leading all the others, whom their officers characterise as being hopelessly stupid and entirely innocent of any common sense.

This is not a particularly favorable comment upon what is often lauded as being the great social and economic advantage of the army—the advancement of the education of young men whose schooling has been neglected. True, there are schools in which those soldiers who come to the army ignorant of orthography may learn to write their names legibly, but it is questionable if beyond this they learn anything of real practical value to them. Young men who have been brought up on farms naturally have their wits sharpened through contact with the new world into which the army introduces them and the new companions whom they meet. Yet experience goes to prove that this kind of education is not always good for them. It makes them dissatisfied with the country life they have hitherto led, and causes them to look upon it as being narrow and cramped, and in order to escape it they remain in the overpopulated towns, adding their quota to the unskilled labor markets. Thus the education received in the army has been largely responsible for the undoing of Germany as an agricultural nation, a result which the military authorities have tried in vain to avoid.

Realizing the seriousness of this, the Kaiser has now thrown all his influence into the movement which is endeavoring to stem the tide flowing townward. What he most wants is the healthy type of soldier who hitherto came from the agricultural districts, but who is fast disappearing. The various schemes favored for the accomplishment of this end are likely to cause some interesting developments in German legislation, especially when the land reform question comes to be finally dealt with.

So long as the army remains one of the greatest factors in the country for the spread of political propaganda, a small holdings scheme, or any other plan, can only meet with partial success. Political influence is working more mischief than the authorities can counteract, much as they try to check it. What gives them the gravest concern is that this political influence is mostly in favor of the spread of the Social Democratic agitation. The members of this party serving with the colors soon succeed in interesting their dissatisfied comrades in the movement, and introduce them to their societies. Those men who later return to the country districts take with them their new political ideas, influencing people in remote parts who have never before heard anything about the party, and this had a tangible effect at the polls at the last elections. It is a very important part of the Social Democratic organization and plan of campaign, and the party, in spite of its recent defeat, succeeded in adding over five hundred thousand votes in its favor in the course of a few years, and that in face of the strenuous efforts of the government to effect a reduction.

The seriousness of this influence is proved by the fact that the authorities do not trust men to serve in the regiments stationed in their native districts. For instance, conscripts from German Poland are made to serve in West Prussian regiments or are brought to Berlin, while those from Elsass and Lothringen are sent to the Polish province and to East Prussia. In this way towns are garrisoned by men who are entire strangers to the districts, so that in the event of a rising among the inhabitants there is little chance of any sympathy between the latter and the soldiers whose duty it would be to deal with them. In any case, the authorities admit that dividing the troops in this way gives them a feeling of greater security.

These are a few of the problems with which this great organization has to contend, and which are apparent to the casual observer. Yet it must not be inferred from them that there is any corruption in the army itself which would in any way affect its efficiency in the field. To be led into such a mistake would be fatal. It is so entirely under the power of the authorities that such a condition is altogether out of the question, nor indeed is there on the part of those serving in it any desire to see it otherwise than the powerful weapon of war that it is, probably the most powerful that has ever been invented.

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Norway is a country of vast mineral wealth. The richest iron mines are situated in the northern part of the country as well as in the Trondhjemske. It has been calculated that the mines at Sydvaranger contain 100 000 000 tons, and that the yearly production will be 600 000 tons. Operations on these mines will probably commence next summer. The work at the Dunderlandsdalen mines has been stopped for some time, but it will be resumed in the near future, when the Swedish method of treating the ore will be employed, with the hope that the works will produce 1 000 000 tons a year. It is estimated that the mines in the Tromso district contain about 40,000 000 tons of ore. Machinery has lately been erected in these mines. The yield will be about 200 000 tons per annum. Several other mines in the north indicate abundance of iron ore.

THE STORY OF SILK.

FROM COCOON TO FABRIC.

BY JOHN L. COWAN.

To the Far East belongs the credit of the beginning of the world's great silk manufacturing industries. For more than three thousand years China jealously guarded its practical monopoly of the precious fabric (a small quantity being produced in India and other parts of Asia) and great caravans laden with raw and woven silks journeyed from the cities of the Celestial Empire to Syria and other countries. The Persians became the intermediaries in this trade between China and Europe, supplying the Greeks and Romans until the middle of the sixth century A. D.

This traffic was interrupted by a war waged by the Emperor Justinian against Persia, and the silk manufacturing industries of the Byzantine Empire were brought to the verge of ruin when two Nestorian monks journeying from China brought relief with a quantity of concealed silkworm eggs. These eggs were delivered to Justinian, who for a time monopolized the silk industry of the Occident, but after his death in 565 A. D. the production and manufacture of silk became widely disseminated. It is claimed that all the silk now produced in Europe is spun by caterpillars descended from those hatched from the eggs smuggled out of China by the two monks thirteen and a half centuries ago.

The silkworm is known to entomologists as the larva of the moth *Bombyx mori*. The eggs are small, resembling turnip seeds, about one hundred weighing one grain. They are hatched by artificial means and the larvae or caterpillars are reared in rooms where they may have an abundance of light and air with little variation in temperature. They are voracious feeders and are kept liberally supplied with freshly gathered leaves of the mulberry tree. They grow rapidly and (as a rule) molt about the sixth, tenth, fifteenth and twenty-third days after hatching. In from thirty-five to forty days, having increased in weight about ten thousand times and grown to a length of about three inches, they climb upon twigs and small branches that have been supplied to them for that purpose and begin spinning their cocoons. In this process the caterpillar ejects from convoluted glands along the sides of its body two lines of viscid semi-fluid filamentous secretion through the spinneret located just under its mouth. The two filaments coalesce into one as they harden. In twenty-four hours after beginning to spin the worker is hidden from view, and in from three to five days the cocoon is complete, and the industrious caterpillar, having lost half its weight and shrunken to half its size, is metamorphosed into a chrysalis housed in an oviform lodge from an inch to an inch and a half in length and from half an inch to an inch in diameter.

Left to the processes of nature, in time the chrysalis will break the filaments of the cocoon and come out a full-fledged but unattractive moth, which thousands of years of domestication have practically deprived of the power of flight. When the moth lays from three hundred to four hundred eggs its mission of reproduction is accomplished and it then dies.

But in breaking the fibers to permit its emergence the moth materially depreciates the value of the cocoon. So only enough to serve as seed are permitted to complete the life cycle, and all other cocoons are placed in steam heaters to kill the occupants.

The cocoon consists of an exterior portion of straggling filaments (by means of which it was anchored to the twigs or branches that supported it) and a closely cemented sheath somewhat resembling parchment around the body of the chrysalis. The threads of this sheath are so tightly glued together that they cannot be unwound until after it has been thoroughly soaked in water. The exterior portion is removed, being known as floss or waste, and is spun along with the material of broken or defective cocoons by methods similar to those used in the case of cotton, linen and other fibrous materials. The filaments of the perfect cocoons are caught on a fine brush, four, five or six of them passed through an eyelet to a reel, and wound upon this is a continuous thread from 800 to 1,000 yards in length. From these reels the silk is taken in skeins, constituting in this form the raw silk of commerce.

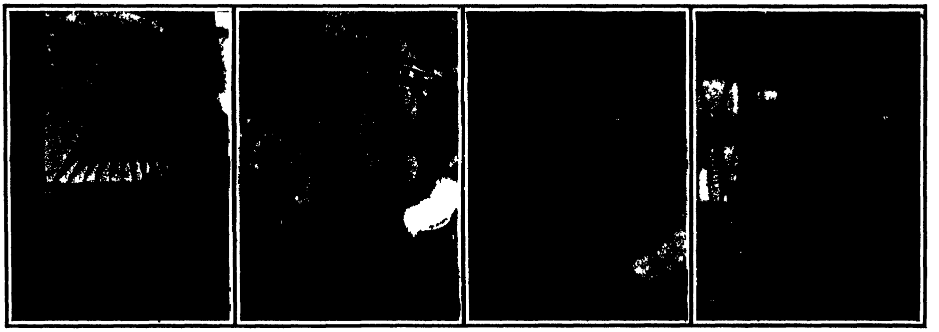
The world's supply of raw silk is derived from China, Japan, India, the Levant, Italy, France, Austria and Spain, amounting to something like [illegible] 000 000 pounds annually. This takes into account only the exports of Asiatic countries, as there is no way of approximating an estimate of what is woven and worn in China. China really produces more silk than any other country, but the vast amount consumed at home (certainly more than half of the production and more than one-fourth of the world's supply) never reaches any center of international trade and never figures in statistical tables. With this qualification the following table (published by the Silk Association of America) indicates the relative importance of the various silk producing countries.

Tussah silk is usually known as wild silk, being the product of an oak-feeding caterpillar of China and India.

The following table of imports of raw silk for the fiscal year ending June 30th, 1909, indicates from what source the silk manufacturers of the United States derive their supplies:

	Bales	Pounds	
Japan	91 552	12 317 520	$44 464 737
China	43 894	5 749 425	15 920 881
Europe	23 165	5 096 300	20 584 965
India	213	38 600	115 163
Total	158 824	23 201 845	$81 085 746

It is evident that by far the largest part of the American supply comes from China and Japan. This reaches the United States by way of the ports of the Pacific Coast, where it is placed on board a "Silk Special"—a train that has the right of way over all the others and hurried through to New York. No train is the object of more care and solicitude on the part of trainmen, as each car is loaded with a product worth $1[illegible] 000 or more, and the train may carry silk worth anywhere from $1 000 000 to $2 000 000.



BUILDING UP THE JACQUARD HARNESS SHOWING THE DIFFERENT STAGES.

THE STORY OF SILK.

SILK ASSOCIATION OF AMERICA.

Raw Silk Production in the Silk Seasons 1904-1905 to 1909-1910 in Kilogrammes and Pounds Including China Tussah Silk.

Crop of (in Kilogrammes)	1909-10 Estimated Kg.	1908-9 Kg.	1907-8 Kg.	1906-7 Kg.	1905-6 Kg.	1904-5 Kg.
Europe	5 230,000	5 558,000	5 917,000	5,750,000	5 495,000	5 917,000
Viz.						
France	650 000	653,000	662 000	605 000	632 000	625,000
Italy	4 100 000	4 490 000	4 820 000	4,745 000	4 440 000	4,900 000
Austria	400 000	340,000	360,000	344 000	345,000	315,000
Spain	80 000	75,000	75,000	56 000	78,000	77,000
Levant	2 900,000	2 700,000	2 981,000	2,515,000	2,435 000	2 186 000
Asia, Total quantity exported*	11,700 000	14,907,000	11 991,000	10 925,620	9 875,120	10,947 350
Viz.						
China, Shanghai†	4,200,000	3,750 000	3 100,000	2 847 100	3 583 000	2 950 047
China, Canton	2 000,000	2 957 000	2 250 000	1 883 000	1,922 120	2 137,785
Japan, Yokohama	5 100 000	7 900 000	6,301,000	5 900,520	4,090,000	5 679,518
Bengals	400,000	300,000	340,000	295,000	280,000	180,000
Total kilogrammes	22 830 000	22 165 000	20 889,000	19,190 620	17 805 120	19,050,350
Tussah raw	1 900 000	1,800,000	852 780	1,285,760	1,281,560	1 175,820
Grand total kilogrammes	24 730 000	23,965 000	21 741,780	20,476,380	18 586,680	20 226,170
Grand total, reduced to pounds	54,519,758	52,833,249	47,931,811	45,081,997	40,965,964	44,590,814

* The production of raw silk in China is an absolutely unknown quantity.

† Excludes Tussah silk.

The figures for Asiatic silks are the actual shipments from the various countries of production, viz. China, Canton, Japan, etc.

The estimated supplies for 1909-1910 are the probable crops for the season, plus the stock on hand carried over from the previous season.

The domestic consumption of Japan is estimated to be approximately 40 per cent of her production. The remaining 60 per cent, which is exported, being, say, 6,301,000 kilogrammes in 1907-1908 season, the total production equals the export divided by 60 and multiplied by 100, which, therefore, amounts to 10,501,666 kilogrammes.

The domestic consumption of China is estimated to be 55 per cent of her production in average years. The remaining 45 per cent, which is exported, being 6,[illegible] kilogrammes from Shanghai, Canton and Tussah in 1907-8 season, the total production equals the export divided by 45 and multiplied by 100, which, therefore, amounts to 13,[illegible] kilogrammes.

All raw silks imported into the United States are taken to New York, which now ranks second only to Shanghai among the world's raw silk markets. Silk in its natural state has an unconquerable affinity for moisture, so that thirty per cent of the weight of a bale may consist of water without anything in its appearance to indicate that it contains an abnormal proportion of that liquid. This is a consideration that the purchaser of a commodity worth from three to five dollars a pound cannot afford to disregard. For this reason the process known as conditioning is necessary preliminary to negotiations for a sale of the product.

Sample skeins are taken from different parts of every bale and weighed with great exactness. These are placed in conditioning ovens having a temperature of 284 deg. F., and desiccated until absolutely devoid of moisture. Then they are reweighed and the difference indicates just how much moisture they contain. This gives a basis for the calculation of the weight of the silk in each bale. To this eleven per cent is added as an allowance for the normal amount of moisture in raw silk. Other tests are made to determine the fineness of the threads, their elasticity, tenacity and twisting qualities, and all data are then at hand necessary to enable buyers and sellers to settle on the important question of price.

FRONT VIEW OF BOX LOOM. HARNESS COMPOSED OF 18 SHAFTS WEAVING FOUR COLORS.

The first step in the manufacture of silk is known as throwing. The skeins are inclosed in light cotton bags and soaked for several hours in warm soapy water. Then they are dried in a hydro-extractor and stretched upon swifts, or skeleton reels adjusted to hold the skeins tightly. Then the filaments are wound upon bobbins and cleaned by being passed from one bobbin to another through the cleaner, which consists of two parallel plates so adjusted that there is just room for the thread to pass through. Single silk (from which pongees are woven) is not doubled or twisted, but is ready for the scourer and dyer just as it comes from the cleaning process. Tram silk is made by twisting two or more singles together, then doubling and twisting again. It is used for the woof thread in weaving. Organzine is made by the union of two or more single threads twisted separately in the same direction and then doubled and twisted in the opposite direction. It is used chiefly for warp threads. The thrown silk is then scoured to remove some of the natural gum so that it will have greater luster and take the dyes better. Shaking, glossing and lustering are processes for which special machinery have been devised. After developing the luster of the silk it is ready for the dyer.

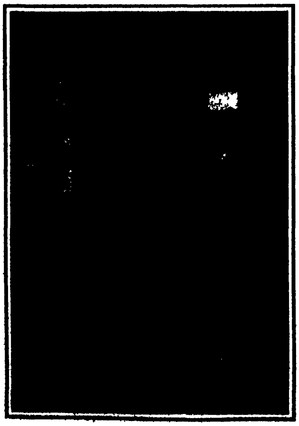
If properly handled, silk is the strongest and most durable of all textile materials, but the various processes of manufacture that remove much of the natural gum cause it to lose so large an amount of its weight that unscrupulous dyers and manufacturers resort to loading, dipping the thrown silk into a solution of bichloride of tin. Some are not content with restoring the original weight of the raw silk, but load it until its weight is multiplied three or four fold. This operation makes the skeins bring more money, but it destroys the durability of the filaments. Stretching the threads to their elastic limit so that a given weight will weave a greater number of yards, and steaming to give the material an unnatural luster, are other processes that prove profitable to manufacturers but costly to the consumers, and that cause many people to regard silk as an uncertain and treacherous fabric, with an inexplicable tendency to split, crack and fall into holes, even though packed away in drawers or hanging up in closets. The use of cheap, inferior and destructive dyes is another practice equally injurious and perhaps still more common, so that the purchase of silks is often a good deal of a risk.

There are in the United States a few great establishments in which all processes of throwing, dyeing and weaving are performed, but as a rule these are conducted as entirely separate industries.

In any woven fabric there are two systems of threads—the warp or chain, running lengthwise of the cloth, and the woof or filling, crossing the chain at right angles. The dyed silks reach the factories in the form of skeins. Skeins intended for the filling are placed upon swifts and wound upon spools or bobbins and thence upon smaller spools called quills that fit into the shuttles. Threads for the warp or chain are wound from the skeins upon bobbins, and these are placed upon an upright frame. Then the threads are passed through the lease reed for the purpose of crossing them as they are placed on the warping mill, so that each thread will always be kept in its proper place. From the lease reed the threads pass through the front reed, and from this over the warping mill, a huge creel eight yards in circumference, fitted with a measuring apparatus so that the warp can be cut off at any length desired. The front reed adjusts the width, controlling the number of threads per inch, varying from 100 in light summer silks to 448 in heavy goods. The warp is placed upon the creel in sections and then all wound off together upon the beam placed in the rear. When complete this beam is removed and placed in position at the rear of the loom. If there are different weaves in the same warp (as for example satin and taffeta) each must be placed upon a different beam, as one weave will take up more than the other, and it is essential that all threads be held taut.

Any description of mechanical operations is necessarily vague and difficult of comprehension unless the printed or spoken word can be supplemented by the eye as an aid to the understanding. Therefore no detailed description of the operation of a modern loom will be attempted, but mention will be made of some of its essential features. It consists of a strong iron frame, at the back of which is the horizontal beam or roller from which the warp unwinds, while at the front is the roller on which the web is wound as woven. Between the two is the harness. This is a series of frames with eyelets, one for every thread or set of threads of the warp. In plain weaving the harness frames are in two sets of [illegible] frames each, one set of which is up while the other is down. The number can be increased to several frames, each acting independently of all the others, for complicated patterns, and in the Jacquard loom the harness becomes a set of threads instead of a frame, so that every thread of the warp can be raised or lowered separately. Between the harness and the take-up roller is the lay, in which is the reed and a smooth projecting under portion along which the shuttles run. The warp threads, crossed as described in the lease reed preliminary to going on the warping mill, are held in position by the lease rods, then pass through the eyelets of the harness and next through the reed. As the harness lifts one set of threads the shuttle flies across the warp through the opening made by such lifting, and the batten (constituted by the reed and lay frame) beats the thread close in to its pre-

REAR OF WARPING MACHINE, SHOWING BEAMING ATTACHMENT.



JACQUARD LOOM WEAVING FIGURED GOODS. THE HARNESS HAS 5,200 THREADS.

Silkworm fifteen days old. Silkworm thirty-five days old. Chrysalis. Cocoon. Moth.

BOMBYX MORI.

HAND-PAINTED DESIGN FROM WHICH PATTERN CARDS ARE CUT FOR JACQUARD LOOM.

THE STORY OF SILK.

de[illegible] The next motion of the harness lifts another set of threads and the shuttle flies back through the opening adding another thread It is a process slow of description but so rapid in performance that the eye can hardly follow the motion of the shuttles back and forth

In weaving figured patterns the Jacquard loom is used or any loom fitted with the Jacquard attachment named from its inventor the ingenious Frenchman Joseph Marie Jacquard The pattern is regulated by an endless chain of heavy pasteboard cards which pass over a quadrangular prism called the cylinder The cylinder is perforated with rows of holes to correspond with horizontal needles that control the warp threads The pattern cards are so perforated that for all warp threads that are to be raised above the filling in the woven fabric holes are cut for the needles allowing them to pass through and thus raising the threads Where a hole is not cut through the pattern card the unperforated cardboard stops the needle and the warp threads are not raised

The making of these pattern cards is of itself an important subdivision of the silk industry The designs are hand painted by skilled artists and designers on papers so ruled that there is a square for every crossing of the threads of the warp and woof Then every square that is painted in (indicating a raised thread in the fabric) must be punched out in the cardboard to permit the passing of the needle controlling the corresponding warp thread so that the design may be carried out

Of course as many colors as desired can be introduced into the warp and by the use of a tier of shuttles each carrying a different color a considerable variety can be woven into the filling

The woven fabric is next placed on a frame and every square inch carefully examined for the removal of dirt knots stains and other imperfections Finally it is taken to the finishing department where the treatment depends somewhat upon the preferences or the inventiveness of the management of the establishment In some cases the goods are singed for the removal of any rough nap The fabric is then sprinkled and sponged with a preparation of wax and gelatine (the exact nature and composition of which in many factories is a carefully guarded trade secret) The final gloss is imparted by calendering in which the fabric is run between a series of superimposed steel rolls ironing it out smoothly and giving the characteristic glossy finish

From this brief sketch of the long and devious journey of a silk thread from the spinneret of the caterpillar to a condition fitting it for the adornment of a butterfly of fashion the reason is plain why silk is the most costly of textiles In every stage of every process of nature art and machinery from the feeding of the silkworms to the finishing touches of a fashionable dressmaker silk is prodigal of labor requiring skilled hands or watchful eyes to assist or supervise every operation It is said that more time is required for the fashioning of a silk dress from the raw materials of the mulberry leaves than is necessary for the building of a locomotive from the ores as they exist in nature and probably the cooperative labors of a greater number of persons contribute to the construction of the ballroom gown than to the construction of a mogul freight engine designed for the steepest of mountain grades The only wonder then is that silk is not so costly as to place it beyond the reach of all but the very wealthy That its price is so reasonable as to place it within the means even of the girls that watch the flying shuttles in the silk mills is due to the fact that the silkworms are fed and cared for and the filaments reeled from the cocoon by the cheapest labor in the world by the labor of the women and children of the Orient the Levant and the south of Europe and to the additional fact that the various processes of manufacture are performed by the most perfect machinery that human ingenuity has ever devised

Numerous and persistent attempts extending over a period of a century and three quarters have been made to introduce sericulture into the United States as a paying industry but these were foredoomed to failure by the evident impossibility of competing with the cheap labor of the older silk producing countries Government support of sericulture has been withdrawn by the discontinuance of appropriations for the purchase of cocoons produced in America and with the failure of a rather ambitious enterprise in Georgia all experiments of this kind appear to have been given up excepting in San Diego Cal where some enthusiasts still hope for success As a matter of fact it is difficult to understand why anyone should greatly desire the permanent establishment of sericulture in America knowing that it would be possible only by the employment of child labor at pitifully inadequate wages

If the United States has failed in the production of raw silk it has achieved a notable success in all branches of silk manufacture excepting in the weaving of certain fabrics in which hand labor is largely necessary This success is mainly due to American ingenuity in bringing silk throwing and weaving machinery to its greatest perfection Mechanical power is applied to silk manufacture to a much greater extent in this country than in any other part of the world

The beginning of silk manufacture in America dates from 1810 when the first silk mill on the western hemisphere was set up at Mansfield Conn In 1815 a silk trimming factory was established in Philadelphia a ribbon factory in Baltimore in 1829 a dress trimming factory in Boston in 18[illegible]4 and sewing silk factories were operated in Florence and Dedham Mass in 1835 In 1838 the first power loom was introduced into America and small manufacturing plants were multiplied until by 1860 New York had 14 little establishments Pennsylvania 3[illegible] Connecticut 22 Massachusetts 20 and New Jersey 9 employing a total of 5 3[illegible]2 persons Yet the relatively small importance of these is shown by the fact that in 1860 the United States manufactured only 13 per cent of the silk goods consumed in the country

In 1860 by the operation of the Cobden treaties England admitted silks of foreign manufacture free of duty and many English throwsters and weavers were forced out of their own markets A number of these came to America bringing with them their machinery and workmen They settled in Paterson N J making that city preeminent as the silk manufacturing center of America This preeminence Paterson still retains although labor troubles in the 80s led to a scattering of the industry many manufacturers locating in Pennsylvania and other States It is doubtless true that the best interests of silk manufacturers and of the country at large will be served by scattering silk mills as widely as possible rather than by concentrating in old industrial districts The wage rate is low so that the industry is suited rather to country districts than to great cities where rents and the cost of living are disproportioned to the earning power of silk mill operatives

From 1860 the silk industry enjoyed steady growth but that this for a time was slow is shown by the fact that in 1870 only 23 per cent of the silk goods consumed in America were of domestic manufacture By 1880 the percentage was 38 in 1890 [illegible] and in 1898 [illegible] In 1868 the importations of raw silk were only 12 149 pounds The next year they amounted to [illegible]26 69 pounds in 1879 to 1 893 311 pounds in 1889 to [illegible]9[illegible]46 pounds in 1899 to 9[illegible]91 14 pounds and in 1909 to the astonishing total of 2[illegible] 3[illegible] 370 pounds

These figures tell an inspiring story of industrial achievement Last year's importations of raw silk amounted to two fifths of the world's total production American silk mills represent an investment of more than $100 000 000 of capital and give direct employment to more than [illegible]000 persons The benefits to capital and labor as represented by manufacturers of machinery and dyestuffs transportation interests jobbers retail dealers dressmakers milliners and scores of cognate interests cannot in any way be estimated

Strange is it not that human intelligence and ingenuity have been able to develop the secretion of an ugly crawling caterpillar into an article of such vast importance to international trade to the worlds of finance industry transportation and merchandizing and to devotees of fashion and all admirers of the beautiful?

A TEST FOR INTELLIGENCE

By Prof R S Woodworth

A good test for intelligence would be much appreciated by the comparative psychologist since in spite of equal standing in such rudimentary matters as the senses and bodily movement attention and the simpler sorts of judgment it might still be that great differences in mental efficiency existed between different groups of men Probably no single test could do justice to so complex a trait as intelligence Two important features of intelligent action are quickness in seizing the key to a novel situation and firmness in limiting activity to the right direction and suppressing acts which are obviously useless for the purpose in hand A simple test which calls for these qualities is the so called form test There are a number of blocks of different shapes and a board with holes to match the blocks The blocks and board are placed before a person and he is told to put the blocks in the holes in the shortest possible time The key to the situation is here the matching of blocks and holes by their shape and the part of intelligence is to hold firmly to this obvious necessity wasting no time in trying to force a round block into a square hole The demand on intelligence certainly seems slight enough and the test would probably not differentiate between a Newton and you or me but it does suffice to catch the feeble minded the young child or the chimpanzee as any of these is likely to fail altogether or at least to waste much time in random moves and vain efforts This test was tried on representatives of several races and considerable differences appeared As between whites Indians Eskimos Ainus Filipinos and Singhalese the average differences were small and much overlapping occurred As between these groups however and the Igorot and Negrito from the Philippines and a few reputed Pygmies from the Congo the average differences were great and the overlapping was small Another rather similar test for intelligence which was tried on some of these groups gave them the same relative rank The results of the test agreed closely with the general impression left on the minds of the experimenters by considerable association with the people tested And finally the relative size of the cranium as indicated roughly by the product of its three external dimensions agreed closely in these groups with their appearance of intelligence and with their standing in the form test If the results could be taken at their face value they would indicate differences of intelligence between races giving such groups as the Pygmy and Negrito a low station as compared with most of mankind The fairness of the test is not however beyond question, it may have been of a more unfamiliar sort to these wild hunting folk than to more settled groups This crumb is at any rate about all the testing psychologist has yet to offer on the question of racial differences in intelligence —Abstracted from a paper read before the American Association for the Advancement of Science

METHOD OF MANUFACTURING SULPHURIC ACID

Experiments have been made in Europe upon a new method of manufacturing sulphuric acid While the usual process of roasting pyrites and similar ores is a very economical one there are countries which do not possess such minerals in abundance and therefore other methods are desired For some time past attention has been given to the use of limestone for this purpose A series of tests was made lately by H Trey and these consisted in the treatment of gypsum and alabaster of very pure variety which came from the basin of the Duna Russia Here are very abundant supplies of these minerals They are treated by means of a very pure silica which is chemically prepared and these ingredients are mixed in the theoretical proportions and are heated to redness in a platinum crucible so as to produce a double decomposition The silica displaces the sulphuric acid which is given off in the state of vapor Taking the loss of weight we estimate the sulphuric acid which is about what theory would give. Such process takes from 30 to 40 minutes heating The time of heat is lessened if we use silicious sand in place of pure silica A test was made using crude gypsum and sea sand and here the time of heat was reduced to 6 minutes The acceleration is due to the catalytic action of iron compounds which the materials contain in very small quantities but there is no benefit in adding iron oxide (0 5 per cent) to the natural pure products as the time is scarcely lessened As the operation is made at a very high heat the sulphuric acid is decomposed as soon as it is given off into water sulphurous anhydride and oxygen but these two gases can be combined by the usual processes so as finally to produce sulphuric acid The sulphuric acid made by the new method has the advantage of being purer than what is given by the usual pyrites process and does not contain arsenic etc The residue of the new process is silicate of calcium which can be used in glass manufacture

At Pola, at the head of the Adriatic, the largest wireless telegraph station on the European continent has recently been fully completed It possesses a tower 300 feet high built on a foundation of glass from which antennæ spread over a ground surface of about eight acres The station house is in two stories the upper serving as a dwelling place the lower as a working place The high tension room is isolated by thick walls and doors and windows of treble thickness During the completion of the installation the station has been constantly tested over comparatively short distances, and has acted faultlessly Full communication has been established with Berlin with a specially erected temporary station at Vienna and later with the city itself, and with Cattaro Thus distances of 500 miles have been covered even before the arrangements were complete, and that with perfect success. Wireless messages were sent to the Kaiser on his yacht during his stay in Corfu, and during his voyage thence to Malta, whereby he was kept in regular communication with his ministers in Berlin The scope of the station will be largely extended during 1910 and 1911.

WATER-VAPOR ON MARS.*

REPLY TO CAMPBELL'S CRITICISM.

BY F. W. VERY.

In Lick Observatory Bulletin No. 169 Prof. Campbell, in the course of comments on Dr. Slipher's and my results which show the presence of water vapor on Mars, says: "Very's results make the intensification of *a* in the Martian spectrum more than twice as great at one time as at another. His greatest intensification is with spectrogram No. 1062, for which Slipher says the *a* band is strong in both Mars and moon, whereas only average intensification was obtained from spectrogram No. 1060, on which the *a* band is all but invisible in both lunar images but conspicuous in Mars, a result apparently difficult to explain" (p. 161). The apparent discrepancy is not at all difficult to explain. It arises from the mode of reduction. By referring to Lowell Observatory Bulletin No. 36 it will be seen that the apparent intensities of the telluric or of the combined telluric and Martian bands on each plate and in each spectrum *have been reduced to the standard of their respective Ha lines*, on the supposition that the latter are solar and therefore constitute one fundamental comparison object which is not subject to change through the variations of our shifting atmosphere, and which also enables us to eliminate any error depending on variation in the appearance of the spectral lines due to changes of focus in the spectrograph which are liable to occur in these long exposures owing to changes of temperature.

The method does not eradicate all possible variations capable of affecting the result, for there remain certain exposure and development factors on which Prof. Campbell frequently comments in describing his own plates, and to which I have alluded in describing the Lowell Observatory plates in Lowell Observatory Bulletin No. 41, p. 223. Lowell Observatory Plate Rm 1062 is a little over developed. The intensification of the *a* band would be normal without any reduction to C standard. In this case the reduction to C does not improve the result, but gives a ratio which is larger than the other ratios, and with a residual nearly twice as great as any of the others. Nevertheless, since the reduction to C appears to be justified and indeed demanded *by the necessities of the case, I cannot throw* out a single aberrant measure for no better reason than that it is aberrant.

Prof. Campbell goes on to say: "It would seem either that Very's methods lead to erroneous quantitative conclusions or that the quantity of water vapor over the whole equatorial region of Mars varied several fold between the dates of observation. Is the latter condition probable?" To this question the obvious reply is that a world-wide variation of aqueous vapor in the course of a few days is next to impossible, but no such interpretation of my measurement is necessary, since the discrepancies are no greater than those attributable to photographic factors. Must I then accept the other horn of the dilemma which Mr. Campbell presents, namely, that "Very's methods lead to erroneous quantitative conclusions"? It seems to me that such a characterization of my work is unjust and unjustified. The measured intensification of little *a* in Mars given in my paper in conventional units from the mean readings for the five plates was nine times as great as the probable error of the mean. No greater accuracy has been claimed for the result than that which is given by the probable error, and I have only *used two significant figures in stating the final value*.

Although the photometric measurements are difficult, the photometric methods are sufficiently trustworthy for the present purpose, and the final limit of accuracy resides in the uncertainties of the photographic process. The only way in which we can get rid of errors due to the circumstances of exposure or of development is by confining the investigation to those spectrograms which are not seriously affected by photographic disturbance, and here, by Campbell's own confession, the Lowell Observatory spectrograms must be given proëminence. He says (p. 162 *loc. cit.*): "In this connection, inasmuch as Very's measures refer to *Ha* (in the region of maximum sensitiveness on my spectrograms) and to *a* (in the region of very little sensitiveness), I note with unusual interest Mr. Slipher's success in giving the *a* region good density without over-exposing *Ha* and *B*. He makes no mention of having used an occulting screen, absorbent screen or other reducer for the region to the violet of *a*, and one must conclude that he depended upon his chemical formulæ to achieve this result. The Mount Whitney spectrograms have intensity curves such that when *a* is fully exposed, *Ha* is essentially lost in over-exposure." In other words, it appears that Dr. Slipher has succeeded where Campbell has failed. It will be understood that I have not seen the Lick spectrograms.

In a letter to me dated January 22nd, 1910, Mr. Slipher says: "The Mars and moon spectrograms were made for the lower end of the spectra, and no regard was given to having the actinic part, but on the other hand no screen was used to reduce the action of that part." This disposes of the doubt implied in the last quotation from the Lick Bulletin.

The last criticism which Prof. Campbell makes upon the method of measurement which I have employed is contained in the following paragraph: "Again, and of special interest in connection with Very's measures: It has long been known that the color curves of Mars and the moon are different, the spectrum of the planet is relatively rich in red. When *the lunar and Martian spectrograms are equally dense* at *Ha* their *D* regions are unequally dense, with the lunar one plainly the stronger. With the *a* regions equalized in density, the *Ha* region is for the same reason a little stronger in the moon than in Mars. Are the ratios of the apparent intensities of *Ha* and *a* in the two spectra not affected by these conditions?" (P. 162.) On this point I answer that the variation in question does make a difference in the result, but only a very slight difference, and one which is negligible where the variation is no greater than in the present case. I have satisfied myself as to this by making measures under conditions far more unfavorable than those in the poorest of the present plates.*

Passing to the criticism made upon the interpretation of these measures, Prof. Campbell asks: "What assurance have we that the air columns through which Mr. Slipher observed Mars immediately after dark and the moon from two to eight hours later were carrying equal quantities of aqueous vapor? He appears to have taken no psychrometer observations at the observatory, but to have depended upon those made at the Weather Bureau Station, a kilometer distant and 105 meters lower, at 5 30 P. M." My answer to this *is that measures of atmospheric transmission made* at a time when there were no marked storm movements at the given place are but little affected by such slight changes as those indicated by the variation of the psychrometer reading at the earth's surface. It is the distribution of moisture through the entire air column that we should like to know, and this is hardly affected by such surface changes as occur in an arid region. The diminution of aqueous vapor so frequently noted at night in arid and elevated situations is presumably due partly to diffusion of moisture into the upper air at a time of day when there is little replenishment by superficial evaporation, and in part to an excessive depletion of moisture in a shallow surface layer of air through deposition of dew, although the latter cannot have been an efficient cause with the low relative humidity found by the Lick observers. The total quantity of water vapor in the entire column is not much changed by redistribution through diffusion, and any great accuracy in the determination of surface humidity would be labor wasted for the present purpose. A mean diurnal or possibly a mean monthly humidity may be quite accurate enough. The great dryness of the *region about Flagstaff and the infrequency of storms*, consequently the moderation of fluctuations in the absolute humidity at this favorable site, must be considered in approaching this question. Variations in the relative humidity, such as are found in a limited layer of air in which cloudy condensation is either imminent or incipient, will have small influence upon the little *a* group, because it lies outside the limits of the diffuse band of absorption produced in a saturated atmosphere. In the daytime, it is true, a tall column of ascending moist air tending to the production of a cumulus cloud and intervening between our instruments and the sun may produce a notable increase in aqueous telluric absorption, but the slight variation in condensation in the comparatively shallow layers of the night clouds need not be further considered in this connection. If we were dealing with the broad aqueous bands in the extreme infra-red spectrum the problem would be different, for in these regions of the spectrum I have found wide variations from the passage of quite invisible masses of aqueous vapor, but it would take exceedingly refined observations to detect such changes in the *a* group. For these reasons we may dismiss Prof. Campbell's suggestion that "Very's numerical results refer chiefly to the relative absorptions of the aqueous vapor in our own atmosphere when Mars was observed at dark and when the moon was observed from two to eight hours (average four and one half hours) later."

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* Lowell Observatory Bulletin No. 41.

* By altering the illumination, the spectral background at either *a* or C was made of the same intensity as that of the comparison spectrum. The omission of this preliminary equalization increases the probable error, even though the direction of relative intensification of the lines remains unchanged.

CONCRETE IN PALESTINE

Deputy Consul John D. Whiting furnishes in answer to an inquiry the following report covering concrete in Palestine and its application in an uncommon way in a German sanatorium in Jerusalem:

Concrete, introduced into Palestine about twenty years ago, was first used only for making floor tiles. The materials used were sand and shells from Jaffa *and cement from Germany*. At first these tiles were made in wooden molds and pressed by wooden mauls and without patterns in either black or white. Some years ago a leading German merchant imported a European machine and produces in his factory in Jaffa different sizes, colors, and designs of tiles, also concrete sewer and water pipes and railings, cornices, steps, and building blocks.

In Jerusalem the opportunity for selling floor tiles, steps, and perhaps cornices is quite large, especially the first mentioned. Little if any opening can be expected for using concrete building blocks, as stone is plentiful and labor for quarrying and dressing it is cheap, while cement and sand are extremely high, since it costs $4 a ton to bring them from Jaffa by rail, although the distance is only about [illegible] miles.

In Jaffa the conditions are reversed. Little stone is found in the vicinity, and much of modern Jaffa has been built from sandstone brought from the ruins of Caesarea and other old towns. This source of supply is now exhausted, and as stone quarries are scarce and the material inferior, concrete building blocks are growing in use. An inexhaustible supply of sand *and shells is right at hand*.

These blocks are now used in building corners of houses and for sides, sills, and arches of windows and doors, the spaces between being filled with sandstone, sometimes plastered over. The houses are sometimes finished off with a concrete cornice; often an entire balcony is thus made, the top brackets, slabs, and railing being molded separately and cemented into the building. Concrete steps are also quite often used, and generally the floors are paved with concrete tiles.

Reinforced concrete has just appeared, calling forth much interest and curiosity from natives, especially masons. When the German Emperor and Empress visited Jerusalem in 1898 a carriage road from the northern suburbs up and along the ridge of Mount Scopus to the summit of the Mount of Olives was built for them by the Turkish government. From the top of Mount Scopus there is an extensive view. Jerusalem lies near by below to the west, and to the east the Dead Sea appears only a few miles off, while it is over 20 miles, and beyond it and the Jordan valley extends the range of Moab.

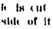
It was this sight that impressed the Empress, and on her return to Germany a large sum was collected for building a sanatorium at this place, which is to be ready for use this spring. The cost is about $380,000, and it will be known as the Kaiserin Augusta Victoria Stiftung. It will be open to the German public. In this building concrete has been used in a different manner from that in general use.

The use of oil fuel is rapidly extending, and the time may be near when it will have an appreciable effect upon the demand for coal. In the United States a bill has been introduced into the Senate which provides for the creation of a reserve oil fuel supply for naval purposes. It also authorizes the Secretary of the Navy to acquire suitable land adjacent to the oil fields of Oklahoma for the erection of tanks for the reserve oil supply, to establish buying agencies, and obtain all information necessary with regard to the cost per barrel of the oil required and the cost per mile of pipes laid. The Secretary is authorized to purchase as fast as the market conditions will justify 25,000,000 barrels of oil for the reserve supply of the United States navy. The British Admiralty has also given a big order for oil to be used in the navy amounting to 225,000 tons.

MICROPHOTOGRAPHY SIMPLIFIED.*

A CHEAP MICRO-CAMERA AND WHAT IT CAN DO.

BY BERNARD THOMAS, M.B., C.M.

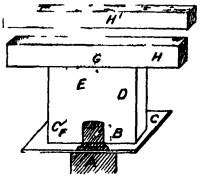
Many readers of Knowledge who are students of the microscope would no doubt be glad to have permanent records of what they see and for this purpose I wish to describe a camera which anyone can make at a nominal cost out of simple material What is wanted is a cardboard box about 4 inches square a pill box or round match box with the ends knocked out that will surround the top of the eyepiece of a microscope an empty quarter plate box some strong wire cardboard black cloth or black paper and plenty of paste The camera if it can be so called is a dark box the eyepiece of the microscope acting as a lens A round hole is cut at the bottom of the open box and on the inside of it is fastened the rim of the pill or match box level with the top of this and with a bend like this  in the middle a piece of stiff wire is passed through the box the wire outside being fashioned into a handle Over the bend in the center of the wire a piece of stiff card is fastened This drops over the eyepiece forming a lid or it can be moved away and will drop back against the side of the box To the open end of the box is pasted an open quarter plate box the bottom of which has been cut out to form a rim to admit the image Now it is all ready and only wants two or three thicknesses of black cloth or black paper pasted on it care being taken that it is sufficiently light proof

To take a photograph the camera is placed on the eyepiece of the microscope which must be upright A piece of ground glass placed on the plate box makes an excellent focusing screen When with careful adjustment the image seems to be clearly defined the box is removed from the microscope to the dark room the plate introduced and the shutter and lid closed A piece of cardboard covered with black cloth the size of a quarter plate and placed over it is an extra precaution The camera is again fitted on the microscope the photograph exposed and then the remaining development done in the dark room Certain points are worthy of note First when viewing with the ground glass the light may be screened by a cloth covered funnel Next it is important to see that the adjustment of the microscope is sufficiently firm and not liable to be altered by the weight of the camera Lastly the camera must be steady and to this end remove the eyepiece and have a piece of stiff cardboard with a round hole in the middle which fits the microscope end of the eyepiece and so placing it in the tube you have a platform on which the camera can rest The diagram will perhaps explain better than any written description

I have taken several photographs with this little camera and the few presently to be described will give an idea what can be done I showed this little camera and some photographs to the Chief Health Officer of Tasmania (Dr Elkington) who is much interested in microscopic work He was so pleased with it that he made one for himself I believe he told his ministerial chief that he had made an addition to his department and installed a microcamera for his work He hoped the government would sanction the expense The Minister was agreeably surprised when he found the item to be just 4½d

With regard to the photographs

Fig 1 will no doubt be identified as a transverse section of the rhizome of the common bracken (*Pteris*) A fibrovascular bundle is well seen among the parenchymatous cells Taken with a 1 inch objective exposure (in daylight) a few seconds



A Microscope eyepiece B pillbox rim for eyepiece C thick cardboard support D dark box E the shutter F handle for shutter G hole through plate carrier H plate carrier H' lid

Fig 2 Leaf of the bog moss (*Sphagnum*) Here the interesting arrangement of the large transparent hooped cells surrounded by the smaller and narrower chlorophyll containing cells is well seen At the lower part of the photograph one of these hooped cells is seen with a hole in it This is taken with a dry 1 10 inch the exposure consequently is much longer about a minute and a half

Fig 3 Leaf of a common moss (*Funaria hygrometrica*) The cells are lined with chlorophyll corpuscles This also is taken with 1 10 inch objective

Fig 4 Taken under the same conditions will be easily identified as Spirogyra with the lovely green spiral bands

Fig 5—The head and forepart of Gammarus the fresh water shrimp One inch objective and exposure about ten seconds

Fig 6—Although owing to unavoidable causes not quite clear is of interest because it shows a rotifer (*Hydatina senta*) in the act of enjoying a good meal of Closteria one of which can clearly be seen in its jaws Of course its somewhat indistinct outline is due to movement.

Several other microphotographs might be shown but I have already encroached too much on the space of your interesting paper I would like to add that all the photographs were taken on special rapid quarter plates (Imperial) and developed with M Q tabloids

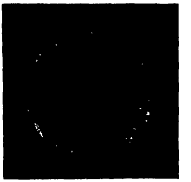


Fig 1 Transverse section of Rhizome of Pteris

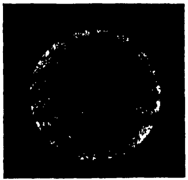


Fig. 2. Leaf of Sphagnum

Fig 3. Leaf of Funaria Hygrometrica

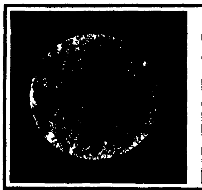


Fig 4 Filaments of Spirogyra

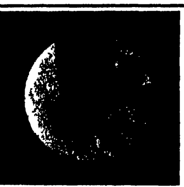


Fig. 5—Gammarus

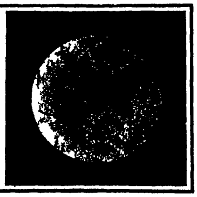


Fig. 6 Hydatina senta feeding on Desmids (Closteria)

MICROPHOTOGRAPHY SIMPLIFIED

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* Knowledge and Scientific News

COST OF POWER FOR VARIOUS PURPOSES

In a paper entitled Cost of Power for Various Industries Under Ordinary Conditions which was presented before the Boston Society of Civil Engineers by Messrs Charles T Main and F M Gunby the following general summary was given of the cost of electrical power for various purposes and under varying conditions The prices quoted are approximately those found in the vicinity of Boston

Power in small amounts and with a varying demand can be purchased for from about 10 cents per kilowatt hour in five kilowatt lots down to about 6 cents a kilowatt for 100 kilowatt lots where the power is used for about 50 hours a month

The rate for a permanent or steady power of 100 kilowatts for 300 hours a month would be about $2 68 per kilowatt hour and for 500 hours a month about $1 84 per kilowatt hour The two conditions mentioned are only used as illustrations to show normal cases as in a city like Boston

Assuming a plant of 2 000 kilowatts capacity the approximate costs and prices for power are given in the following table

Kind of Plant and General Use	Hours per Year	Cost per Year			Cost per K W Hour
		K W	E H P	I H P	
Textile (engine)	3 000	$32 00	$23 80	$20 80	1 066c
Textile (turbine)	3 000	30 00	21 00		0 [illegible]
Paper mill (engine)	7 200	57 00	42 50	37 00	0 792c
Paper mill (turbine)	7 200	52 00	38 80		0 722c

The above figures are for cases where no waste products are used for manufacturing

For electric lighting or railway work with a load factor of 30 per cent the cost would be about $1 55 per kilowatt hour or $40 per kilowatt year This is $29 80 per engine horse power year or an equivalent of $26 00 per indicated horse power year

For paper mill work 24 hours a day, 6 days a week power only $57 00 per kilowatt year or 0 792 cents per kilowatt hour for an engine plant or about 8 per cent less for a turbine plant If the waste products were used for manufacturing these costs might be reduced by about one third

For use in industrial plants 10 hours a day 300 days a year straight power would cost $32 00 per kilowatt year If heating is done by exhaust steam, these figures may be reduced by about $1 20 per kilowatt or to say $30 60 per kilowatt year This would be about $23 00 per engine horse power and $20 00 per indicated horse power year

For colored textile mills making use of exhaust steam and water of condensation, the original cost of straight power would be the same as that given in the preceding paragraph This may be reduced by using the exhaust steam and waste products by from $2 00 to $12 00 per kilowatt year depending upon the amount of steam and waste products used

The common price for hydro electric power 24 hours a day 6 days a week is from $30 00 to $40 00 per electrical horse power or $40 00 to $53 50 per kilowatt

The common price for hydro-electric power 10 hours a day 3 000 hours a year, is from $20 00 to $25 per electrical horse power or from $27 00 to $33 50 per kilowatt —Machinery

One hundred and fifty locomotives of the Lehigh Valley Railway are being equipped with a new fuel-saving device On all locomotives the air brake pumps are operated by steam and it has been the practice to conduct the exhaust steam from the pumps to the smoke-box to which the stack is attached and then to release it, causing a draught Considerable work is done by the brake pumps when the locomotive is at a standstill, thus causing a needless loss of fuel By the new arrangement the exhaust steam is carried outside instead of inside the smoke stacks Tests made by the above-named railway show that the company is saving about 1,000 pounds of coal per locomotive on the descent of the bank from Glen Summit to Pennhaven Junction, Pa., a distance of 25 miles.

A WAVE-LENGTH COMPARATOR.*

STANDARD MEASUREMENT IN WAVE-LENGTHS OF LIGHT.

BY A. E. H. TUTTON.

The employment of the principle of the interference of two rays of monochromatic light derived from the same source one retarded behind the other by having to traverse a longer path for the production of rectilinear interference bands constituting a scale of half wave-lengths has now been brought to such perfection that this highly refined scale may be used for the measurement of short distances or small movements of any description whatsoever The accuracy is absolute to the tenth part of a scale division the twentieth part of a wave length of light and is actually measurable with the most ordinary micrometer to the one hundredth of a scale division corresponding to the two hundredth part of a wave length Now a wave length of even the grossest radiations employed those of red light derived from either cadmium vapor (0 00064 8 millimeter) or hydrogen (0 0006562 millimeter) is a forty thousandth of an inch so that the measurable unit is an eight millionth part of an inch

The finest trustworthy measurement by mechanical means (such as the Whitworth machine) or micrometric devices (such as the most refined thickness measurer) is the one thousandth of a millimeter or the twenty five thousandth of an inch Moreover the amount of possible error with either of these mechanical methods of measurement or the interference method is from one to two units of the respective scales Hence the interference method is only subject to a possible error of one three hundred and twentieth the magnitude of that to which the mechanical mode of measurement is liable

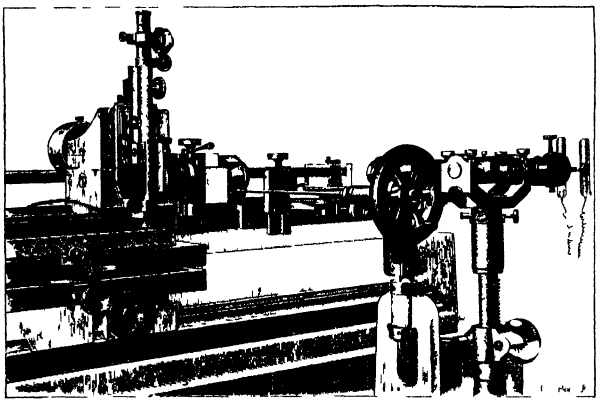
The interference method was first seriously employed by Fizeau who utilized it for the determination of the thermal expansion of crystals and other small bodies It was materially improved by Abbe and Pulfrich and more recently both for the same crystallographic purpose and for general purposes by the writer who has also extended its use to the measurement of the modulus of elasticity of crystals and small bodies or small quantities of substances in general

It will be remembered also that Prof Michelson of Chicago has recently adapted his entirely different mode of producing interference fringes in this case circular to the determination of the number of wave lengths of red cadmium light which he has proved to be the most homogenous of all radiations yet known to us in the French meter By employing a graduated series of glass plate *etalons* or intermediate standards each double of the preceding one commencing with a basal one of half a millimeter in which the actual number (1 212) of half wave lengths was counted the number of wave-lengths of red cadmium light in the meter was eventually found to be 1 553 163 This number has since been confirmed by the independent method of Fabry and Perot in which circular fringes are also produced

Three years ago the writer was invited by the Standards Department of the Board of Trade to adapt his interferometer to the purposes of a wave length comparator of measures of length and a memoir recently published in the Philosophical Transactions of the Royal Society (Phil Trans A 1910 vol ccx p 1) with the consent of the President of the Board of Trade describes the instrument which has now been installed in the Standards Office The memoir also comprises an appendix concerning the possible employment of wave-length rulings on metal as defining lines on standard bars with suggestions for their use along with the interference bands of the interferometer in an original method of determining the total number of wave lengths in the British yard

A general view of the interferometer and one of the duplicate microscopes of the comparator together with sufficient of the bar carriage to enable some idea of the whole apparatus to be gained is given in the accompanying illustration

The whole instrument is mounted on a large stone block, resting on isolated concrete foundations On a small stone pedestal similarly isolated in front of the large block rests the pedestal of the auto-collimating telescope and attached Geissler tube of the interferometer In the common focal plane of the telescope objective and eyepiece opposite the junction of this main optical tube with the rectangularly attached side tube carrying the Geissler tube a small totally reflecting prism is arranged half covering the focal aperture A still smaller rectangular stop or opening in a plate in front of and almost touching that one of the perpendicular prism faces which is directed toward the objective and lies in the focal plane very close to the edge dividing the closed half from the open half is the effective source of the interfering light the rays from the Geissler tube received on the other face of the right angled prism are arranged to fill this stop after reflection from the hypotenuse of the prism The rays proceed from the stop to the objective which they are arranged to fill with light and thence pass out of the telescope as parallel rays in the path of which the dispersion and interference apparatus is placed The rays return to the telescope from the latter along practically the same path but after reentering the telescope instead of returning to the little rectangular stop their origin they are deflected just sufficiently to one side to form an image of the stop the same size as the original in the open semicircular aperture of the focal plane within a couple of millimeters of the real stop This closeness to identity of path of the outgoing and the incoming rays and consequent normal incidence on the reflecting glass surfaces of the interference apparatus is largely responsible for the magnificent field of parallel straight lined interference bands which the author's interferometer affords for it fulfills an essential condition for perfect interference



CENTRAL PART OF COMPARATOR SHOWING INTERFEROMETER

With the ordinary eyepiece in position the images of the stop reflected from the various surfaces of the interference apparatus can be focused adequately magnified and viewed during their adjustment to the theoretically ideal positions But when this eyepiece is replaced by a special one consisting of a Ramsden micrometer combined with an additional lens between the latter and the focal plane the telescope is converted into a low power microscope which focuses simultaneously the interference bands a little silvered reference ring in the center of one of the two surfaces reflecting the interfering light and the micrometer spider lines There are two parallel vertical spider lines one is adjustable by the left drum head of the micrometer so as to be able to set it at any convenient distance from the other in order to include a single band and most of the reference ring between them and both are moved together by the other (right) measuring drum in order to be able to determine the band width and any fraction of a band which may have passed the reference center

The dispersion apparatus consists of a Hilger constant deviation prism which enables the desired spectrum ray to be isolated from all others and that alone delivered to the interference apparatus The rays are deviated exactly at right angles by this prism toward the interference apparatus the surfaces of which they strike at normal incidence after which they return through the constant deviation prism (thus securing double dispersion) to the telescope The prism is mounted on a divided circle so that it may be calibrated for the delivery of light of any desired wave-length if desired and has numerous adjustments Such calibration is not essential however as the particular image of the origin step in the cell corresponding to the spectrum bright line of cadmium or hydrogen can be adjusted visually on removal of the front lenses of the Ramsden eyepiece

The interference apparatus consists of three circular and thick glass disks the third of which is of black glass polished to an absolutely true plane on its outer surface which is one of the two important surfaces concerned in the production of the interfering light It is ground on the back surface by which it is attached in an adjustable manner to the right micro scope of the comparator the movement of which it is to record The other two are larger disks of colorless glass identically similar the two truly plane surfaces of each disk not being strictly parallel but inclined at the minute angle of [illegible] minutes The left surface of that one nearest to the black glass disk is the second surface concerned in the interference and approaches the black glass within a millimeter the second is a duplicate one merely introduced on the right of it to correct for the slight dispersion produced by the 3' min of inclination the two being set oppositely as regards the direction of the wedge The [illegible] min inclination is just adequate to deflect out of the field of the telescope the reflection from the other (right) surface of the left colorless disk and both images from the countervailing disk are got rid of by a slight tilt in the rectangular direction All the many adjustments required are provided for in the mounting of the two colorless disks on a separate carrier sliding along the face of the upper V and plane bed of the comparator

The apparatus as described up to this point is the interferometer

The comparator consists of two V and plane beds nearly 7 feet long of specially homogeneous cast iron and worked truly plane with consummate care together with their contents they are arranged stepwise one on the top of the stone block and the other 7½ inches below and in front On the upper one slide the two duplicate microscopes and on the lower one the standard bar carriage and accessory fine adjustment fittings The carriage is given a longitudinal motion a transverse motion adequate to bring either of the two bars to be compared under the microscopes as well as fine adjustments for azimuth height and level thus enabling the defining marks on the bars to be readily focused without touching the microscopes if it is so desired

Each miscroscope is carried on a solidly constructed slider on the V and plane bed by which its coarse adjustment for position is effected The microscope bearing bracket is not however fixed directly to this slider but to a second one sliding over the first also with V-and plane contact and with the further control of the movement of a cylinder within a cylindri cal boring The fine sliding is effected by means of a most carefully made screw of fifty threads to the inch on which the success of the instrument depends and which carries at its outer end a large milled head for hand rotation and a wormwheel of 100 teeth gearing with an endless screw which can either be rotated by hand by means of a milled head or by means of a shaft and a large wheel seen in front in the illustration One complete rotation of the latter corresponds to the movement of the microscope and the black glass interference disk to an extent which causes the passage of fifteen interference bands past the reference center More than an inch of movement of the circumference of the wheel is necessary to effect the passage of a single band Two thirds of the dead weight of the microscope and slider are taken up by four spring pistons and the movement of the slider by the screw is only a push in either direction against the walls of a recess in the free slider there being absolutely no strain anywhere Hence this movement of the microscope is not only an excessively fine one but also so steady that the bands pass with a precision which leaves nothing to be desired and each band may be held for any length of time for counting purposes

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* Nature.

Each microscope is provided with a micrometer eyepiece with spider lines arranged as in the interferometer The fine adjustment is made exceptionally steady and regular Two sets of objectives are provided one pair for observing the defining lines in the countersunk wells near the ends of standard bars with a magnification of 100 diameters and without penetration of the well by the objective and the other set for use with the wave length rulings

The defining lines of whatever character are illuminated (with critical illumination) by the brilliant image of a distant Nernst lamp with the aid in each case of a little reflecting prism a collimating lens an iris diaphragm and a glass plate mirror above the objective all provided with fine adjustments This avoids all heating effect on the bars and the last traces of heat rays are filtered out by a thick water jacket in front of the lamp and its beam parallelizing lenses The illumination of the wave length rulings one forty thousandth of an inch apart is excellent with the 1 12th inch dry objectives employed and the definition truly surprising

The temperature of the whole comparator room is maintained at the official temperature 62 deg F entirely electrically both as regards artificial heating and the thermostat which is original So sensitive is the latter that the entrance of a person into the room is immediately followed by the extinction of one of the heating lamps to compensate for the extra warmth introduced

The finest defining lines yet employed on any line measure bars are those on the platinum iridium copy of the imperial standard yard Yet even each of these has a thickness equivalent to fifteen interference bands The defining lines on the Imperial yard itself are three times as coarse Hence we have now arrived at that stage in the competition between defining lines and refinement of measurement when the latter has far surpassed the former It was for this reason that the writer took up the investigation of wave length rulings with the idea of their possible use as defining lines commensurable with the increased refinement of measurement Mr H J Grayson of Melbourne whose wonderfully fine rulings have recently been much discussed in microscopic circles has kindly made a number of rulings of 1/40 000th inch fineness which preliminary experiments indicated as feasible for the required purpose on polished speculum metal and platinum iridium which appear particularly the former perfectly satisfactory The forty thousandth of an inch being the wave length of red hydrogen or cadmium light the distance between two lines ruled at this interval corresponds to only two interference bands With the 1 12th inch dry objectives the lines moreover are as cleanly cut as spider lines and the thickness of a line is less than half a wave length Five such lines are ruled in succession the central one being considered as *the* defining line A strong finder line is ruled on each side of the five and two other strong ones at right angles in order to localize a central part of such a system It appears perfectly feasible to carry out a stepping off process for the counting of the total number of wave lengths of cadmium red light in the British yard in which such rulings would take the place of the glass plates of the Michelson or Fabry and Perot *étalons* a base line of the thirty second part of an inch being first actually counted in bands with the aid of the interferometer between limits defined by two such systems of rulings The final fraction of every stage in such a process could be absolutely checked by the interferometer in all cases where Michelson found it possible to do so that is so far as interference bands are still visible about four inches, and as it has already been proved that the accuracy with the rulings is almost as great as with interference bands this checking comes to be as imperative as when only the coarse existing defining lines are available Hence the future before these rulings appears likely to be both interesting and important

MENDELEEFF'S LIFE AND WORK.*

THE CAREER OF A GREAT CHEMIST.

Concluded from Supplement No 1789, Page 251

In March 1869 Mendeléeff communicated to the Russian Chemical Society an enunciation of the principle of periodicity and a statement of some of the consequences of this recognition of the relation of properties to atomic weight throughout the whole range of the known elements and this statement was accompanied by a table which while it bears a close resemblance to Odling's table of 1864 was apparently connected in his mind with an idea which became clearer and more decisive in the modifications which he immediately afterwards introduced into the arrangement

Mendeléeff's First Table of the Elements

						Ti	50	Zr	90		180
						V	51	Nb	94	Ta	182
						Cr	52	Mo	96	W	186
						Mn	55	Rh	104 4	Pt	197 4
						Fe	56	Ru	104 4	Ir	198
					Ni	Co	59	Pd	106 6	Os	199
H	1					Cu	63 4	Ag	108	Hg	200
		Be	9 4	Mg	24	Zn	65 2	Cd	112		
		B	11	Al	27 4	?	68	Ur	116	Au	197 ?
		C	12	Si	28	?	70	Sn	118		
		N	14	P	31	As	75	Sb	122	Bi	210 ?
		O	16	S	32	Se	79 4	Te	128 ?		
		F	19	Cl	35 5	Br	80	I	127		
Li	7	Na	23	K	39	Rb	85 4	Cs	133	Tl	204
				Ca	40	Sr	87 6	Ba	137	Pb	207
				?	45	Ce	92				
				?Er	56	La	94				
				?Yt	60	Di	95				
				?In	75 6	Th	118				

From this arrangement in which the elements are placed in vertical columns according to increasing atomic weight so that the horizontal lines contain analogous elements again according to increasing atomic weight Mendeléeff deduced the fundamental principle which he expressed as follows The elements arranged according to the magnitude of atomic weight show a periodic† change of properties

Previous students of the subject had been for the most part struck with the relations obviously subsisting between the members of the several natural families of elements but had with few exceptions failed to perceive that there must be a *general* law binding the whole together However Mendeléeff with that noble sentiment of justice which always animates the truly scientific mind admits that the idea of a general law had already been foreshadowed by others (Faraday lecture 1889)

Mendeléeff's table of 1869 was subsequently in 1871 modified so as to assume the form with which we have all been so long familiar and which is to be found in every modern text book Thus it may be claimed for Mendeléeff that he was actually the first not only to formulate a general law connecting atomic weights with properties but was the first to indicate its character and as he himself (Principles 1905 II p 28) has pointed out he was the first to foretell the *properties of undiscovered* elements or to alter the accepted atomic weights in confidence of its validity The time was in fact ripe for the enunciation of this general principle and the suggestion once given the relations embodied in the law could not fail to attract other chemists Accordingly in December 1869 Lothar Meyer with such knowledge of Mendeléeff's scheme as could be derived from the imperfect German version of his paper of the previous March proved himself a convinced exponent of the idea by contributing to Liebig's *Annalen* a paper containing a table substantially identical with that of Mendeléeff and his famous diagram of atomic volumes which more clearly even than the tabular scheme illustrates the principle of periodicity

The history of science shows many instances of the same kind Great generalizations have often resulted from the gradual accumulation of facts which after remaining for a time isolated or confused have been found to admit of co-ordination into a comprehensive scheme and this once clearly formulated many workers are found ready to assist in its development The case is nearly parallel to the recognition of the operation of natural selection by Darwin and Wallace or it might be compared to the discovery of oxygen by Priestley and Scheele and the utilization of this knowledge by Lavoisier In each case much preparatory work has been done and a body of knowledge had been gradually accumulated which when duly marshaled and surveyed by the eye of a master could scarcely fail to reveal to him the underlying principle The full consequences however would appear only to a few

I regard it unnecessary in the presence of the fellows of the Chemical Society to review with any detail the multitudinous applications of the scheme of the elements constructed on the basis of the periodic law These are the commonplaces of modern theoretical chemistry They are embodied in every text book of any importance and are related by every lecturer and teacher as familiar and indisputably recognized consequences of the system We may therefore pass lightly over the story of the prediction by Mendeléeff of the properties of undiscovered elements confirmed so remarkably by the discovery of scandium gallium and germanium and related in dramatic language by Mendeléeff himself (Faraday lecture) We may also pass over the applications of the system to the correction of atomic weights illustrated by the case of beryllium the recognition of previously unnoticed relations and the discovery of new elements notably the companions of argon (Ramsay Presidential Address to Section B British Association 1897 and Proc Roy Soc 1898 lxiii 437)

It will be more profitable to consider a few of the difficulties which still encumber the application of the law and which while limiting our acceptance of it in an unqualified form as applicable to the whole of the elements tempt the speculative mind to wander in wide fields of conjecture

Can it be truly said that the elements arranged in the order of their atomic weights show without exception periodic changes of properties? This question has been propounded already but has never been fully discussed even by Mendeléeff An examination of the facts seems however to indicate the possibility of some other principle which while it does not supersede the periodic scheme would if it could be recognized supplement it

From a consideration of the almost unbroken sequence in the atomic weights of the known elements it seems probable that few additional elements are to be expected except possibly one following Mo and another following W save in the region from Bi to Ra This suggests the remark that after all it is not necessary to assume that the materials of which the earth consists should necessarily include a sample of every possible element indicated by such a scheme Some which are missing from terrestrial matters may perhaps be responsible for phenomena recognizable by the spectroscope in stars or nebulæ far distant in cosmical space The unexpected however often happens and remembering the discovery of terrestrial helium it is permissible to hope that some of the vacant spaces may hereafter be filled by earthly occupants

There is one important point to be noted here namely that if the so called rare earth metals praseodymium neodymium samarium gadolinium terbium dysprosium erbium ytterbium and others of which the existence is doubtful do lie in the position indicated the original statement of the periodic law breaks down at this point

One result of the recognition of the periodic law is that theories concerning the genesis of the elements have received a stimulus previously unknown It is, however interesting to note the attitude of Mendeléeff toward this question, and the small extent to which this attitude appears to have become modified with the lapse of time When in 1889 twenty years after the discovery of the law he composed the Faraday lecture, he seems to have regarded speculation in this direction as a kind of abuse of the periodic system

Fifteen years later after the discovery of the argon group of elements of the phenomena of radio activity, and of radium it became necessary to consider the relations of these substances to the periodic scheme In a remarkable article contributed to the new Russian

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* The Mendeléeff Memorial Lecture delivered before the Chemical Society on October 21 1909 by Sir William A Tilden F R S Abridged from the Journal of the Society for December 1909

† Here an error in the German translation does an injustice to the original inasmuch as the Russian word for periodic is rendered stufenweise (gradual)

Encyclopædia and subsequently printed as Appendix iii to the 'Principles (English edition 1905), Mendeléeff gives a new table of the elements in which places are found not only for the argon group and radium, but for two hypothetical elements which are placed before helium and designated *x* and *y*

The *y* in the table is supposed to be an analogue of helium, and may be identified hereafter with coronium which has been recognized in the sun's coronal atmosphere This gas would have according to Mendeléeff a density about 0 2 and therefore a molecular weight about 0 4 or about one tenth that of helium

x is the 'ether of the physicist for which Mendeléeff, disregarding conventional views supposes a molecular structure He also assumes that like the argon group this element is chemically inert and possesses a very low density and atomic weight estimated at 0 000 000 000 053

Chemists and physicists have however found it impossible to resist the fascination of this problem and accordingly there have been many hypotheses as to the original of the elements and the nature of their connection with one another These seem to be inseparable from the periodic scheme itself which at once provokes the inquiry Why do these numerical relations occur and what is the meaning of them if they do not point to a common genesis or the operation of some process of evolution?

Hypotheses concerning the evolution of the elements have hitherto been usually based on the assumption that the successive stages of condensation of elemental matter proceed from a single primary stuff which by a process analogous to polymerization among carbon compounds gave rise to atoms of greater and greater mass which were stable at the prevailing and any low temperature The physical cause of the successive condensations is supposed to be a falling temperature It is of course possible to imagine that if to the stuff of which hydrogen atoms consist are added successive portions of matter of the same kind stable structures may at intervals result which we know as the atoms of the elements helium lithium beryllium boron carbon nitrogen oxygen and fluorine provided the idea of internal structure in these atoms is allowed Otherwise from the mere accretion of matter upon a central nucleus there seems no sufficient reason why there should not have been formed an indefinite number of intermediate masses corresponding to an indefinite number of what would be called elements Further it is difficult to understand why simple increase of mass should change say oxygen into fluorine while a further addition of the same kind should change negative flourine into inert neon or positive sodium The possibility of the condensation of a single protyl so as to produce at successive though unequal stages of cooling the elements known to the chemist has been most ably discussed long ago by Sir William Crookes

This hypothesis however was put forward long before the work of Sir J J Thomson and his school was given to the world and the electron was accepted as a physical reality The hypothesis that one elemental stuff may give rise to the whole array of known elements by a process of condensation accompanied by a loss or gain of electrons the mass of which is approximately one thousandth of the mass of an atom of hydrogen forms the subject of a paper by Mr A C G Egerton in a recent number of our Transactions (1909 xcv 239) The atomic weights calculated by his formula agree closely with the experimental atomic weights of the first fifteen elements but the hypothesis gives no explanation of the facts observed in the physical properties of the elements arranged according to the Mendeléeff scheme their alternation of odd and even valency the transition from positive on one side of the table to negative on the other the periodicity of properties shown by the sudden change of character in passing from fluorine to the next element whether it be neon or sodium

Another paper by Messrs A C and A E Jessup (Phil Mag 1908 [vi] xv 21) has recently provided a hypothesis of an entirely different character From a study of the spectra of the nebulæ these authors have been led to assume the existence of two hitherto unrecognized elements to which the names protoglucinum and protoboron are assigned These with hydrogen and helium are supposed to represent *four* initial substances or protons which by condensation directly or indirectly give rise to all the rest of the elements The arguments of these authors are ingenious but rather artificial in view of the fact that the number of groups in the periodic scheme to be provided for is greater than four

In the Mendeléeff chart of the elements there is nothing more striking than the gathering of the negative elements toward what may be called the N E, and the segregation of the positive elements toward the S W, the center of the intermediate territory being occupied by elements which play a more or less undecided part I have elsewhere (Presidential Address, 1905 Trans lxxxvii, 564) directed attention to the fact that carbon, at any rate is not directly deposited by electrolysis from any of its compounds, with positive hydrogen on the one hand, or negative chlorine on the other. I believe the same is true of silicon these two elements *standing in a middle position between the extremes occupied* by lithium and fluorine respectively

If we assume that atoms are made up of two parts (protyls) positive and negative in proportions which determine by the preponderance of one or the other whether the element shall exhibit the positive character of a metal like lithium or the negative character of a halogen we arrive at a hypothesis which recalls the ideas put forward nearly a century ago by Berzelius His views are familiar to every student of the history of chemistry but have long been relegated to the lumber room of worn out doctrine The last few years have however given us the remarkable experimental investigations of J J Thomson already referred to and the new conceptions concerning the nature of atoms which revive the fundamental idea that they are made up of two components*

Setting out the known elements in the order of the numerical value of their atomic weight we find that between the first three elements H 1 He 4 and Li 7 the difference 3 is greater than would be expected by comparison with the difference noticed between the elements of greater atomic weight which immediately follow them In order to satisfy the hypothesis just put forward there appears to be wanting an element which should stand in the same relation to fluorine as hydrogen to lithium This would have an atomic weight 2 7 approximately Whether this exists and whether its existence is indicated by the unappropriated spectral lines of nebula or corona can only be a matter of conjecture Mendeléeff in his (190) latest speculations concerning the possibility of still undiscovered elements has suggested the existence of a new element of the halogen group with an atomic weight about † but as already sufficiently shown he accepted no hypothesis which involved any idea of the composite nature of the elements It would therefore have been foreign to his system to employ this element in any such manner

The conceptions presented to us in J J Thomson's work permit of several supplementary hypotheses especially the idea that if atoms are really made up of smaller corpuscles these are not thrown together in *confusion but as he has shown must be distributed* within the mass in a definite order which is determined by the attraction of the electropositive shell and the self repulsion of the negative corpuscles included in it Once the idea of structure within the *atom is admitted the possibility presents itself of there* being for the same mass more than one arrangement corresponding to what is called isomerism in compounds

I have dwelt at some length on these various hypotheses because the discussion of the subject to which they relate indicates in my opinion one of the consequences of the promulgation and general acceptance of the periodic scheme of the elements This is however not the only result of the recognition of its validity and usefulness by chemists generally That the elements stand in a definite relation to one another implies that their compounds also fall into their places in an orderly system and consequently a basis is provided for the complete systematization of the whole science of chemistry There is scarcely a treatise on chemistry which does not bear evident witness to this influence and this is perhaps not the least among the services rendered by this generalization for not only is the learner enabled to remember a much larger number of facts than previously but he is led to perceive a connection between phenomena and processes which was almost entirely wanting so long as practical chemistry consisted mainly of a bundle of recipes Here it is fitting that we should glance at the famous treatise by Mendeléeff himself The Principles of Chemistry of which we possess three editions in English the last of which issued in 1905 is a rendering of the seventh edition (1903) of the original An eighth Russian edition began to be issued in 1905 but is incomplete To this remarkable book it is impossible to do justice in a brief notice or to communicate to those who have not read it an adequate impression Clearly it is a work of genius but such works are not always the most suitable for beginners though for the advanced student nothing can be more inspiring The Principles embody in reality two distinct treatises for the text which is written in an easy style open to quite straightforward reading is accompanied by notes which are often more voluminous and usurp entire pages Even the preface is attended by these commentaries which are all interesting as showing the spirit of the writer and the restless activity of his mind

Little more remains to be said In the seventeenth century Robert Boyle taught us how to distinguish elements from compounds and how to give the word element a definite connotation clearly distinguishing it from the elusive and fantastic language of the alchemists In the eighteenth century Lavoisier showed the true nature of the most familiar of chemical compounds namely acids bases and salts and helped to lay the foundation of quantitative chemistry At the beginning of the nineteenth century Dalton gave to chemistry the atomic theory of which it is not too much to say that it provided the scaffold by the aid of which the entire fabric of modern theoretical chemistry has been built up Sixty years later this conception developed and adorned by the labors of an army of earnest workers has been shown to us in a brilliant new light thrown over the whole theory by Mendeléeff

The views of Boyle of Lavoisier and of Dalton have been corrected by experience and broadened by extended knowledge but the fundamental and essential parts of their ideas remain and their names are immortal In like manner the expression of the periodic law of the elements as known to the present generation is destined we may believe to be absorbed into a more comprehensive scheme by which obscurities and anomalies will be cleared away the true relations of all the elements to one another revealed and doubts as to the doctrine of evolution resolved in one sense or the other, but as with the atomic theory itself there is no reason to doubt that the essential features of the periodic scheme will be clearly distinguished through all time and in association with it the name of Mendeléeff will be forever preserved among the fathers or founders of chemistry

In an article published in the Z physik Chem A Coehn and H Becker describe some investigations of the photochemistry of sulphuric acid The authors studied the formation of sulphur trioxide from sulphur dioxide and oxygen under the influence of the *radiation from a quartz mercury lamp* Experiments made with a quartz reaction vessel mounted within a mercury lamp showed that the formation of sulphur trioxide proceeds fairly rapidly even at the ordinary temperature and more rapidly at higher temperatures *The equilibrium is quite distinct from that* attained in daylight With the mixture 2SO O equilibrium is attained with a production of 6[illegible] per cent of sulphur trioxide and this equilibrium can also be attained starting from sulphur trioxide At 160 deg C with the gases confined in the reaction chamber equilibrium was attained in 1 hour In daylight at temperatures below 1[illegible]0 deg C the equilibrium condition corresponds with practically 100 per cent of sulphur trioxide Again the light equilibrium (attained on exposure to the radiation from the mercury lamp) is not displaced by a rise of temperature up to 800 deg C whereas the temperature of dark equilibrium (in daylight) is displaced considerably by a rise of temperature above 4[illegible]0 deg C With a mixture in the proportions SO O = 1 13, for example at 800 deg C the yield of sulphur trioxide is 80 per cent on exposure to the rays from the mercury lamp whereas in daylight the yield is 44 per cent of sulphur trioxide The temperature coefficient of the velocity of the photochemical reaction was found to be 1 2 The authors consider that a technical photochemical process for the production of sulphuric acid is quite feasible since on using air in place of oxygen no oxides of nitrogen are formed Some experiments were made with a special mercury lamp composed essentially of a quartz tube 11 centimeters long and 1 8 centimeter diameter This was inclosed in a tube of opaque English quartz 100 centimeters long and centimeters diameter the annular space between the two serving as a reaction chamber At 1[illegible]0 deg C and with the gaseous mixture passing at the rate of 100 to 1[illegible]0 cubic centimeters per minute yields of 6[illegible]4 70 8 92 and 90 per cent respectively of sulphur trioxide were obtained with 0 78 0 66 8 7 and 9 molecules of oxygen per molecule of sulphur dioxide

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The State railway *from* Magdeburg *to* Halle *via* Zerbst and Leipzig states the Electrical Engineer will soon be electrified throughout its entire length and also the branch line from Dessau to Bitterfeld which is about 16 miles long The total length of the line between Magdeburg and Halle is about 9[illegible] miles It taps all the important brown coal fields in the neighborhood of Mulde which urgently require better and cheaper means of transport The power will be provided by a station at the small Prussian village of Muldenstein which has been selected because brown coal for fuel is abundant there The current used for the electric locomotives will be a high tension alternating current supplied at 10 000 volts The whole cost will exceed one million sterling at all events but it is said that it may be considerably more

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*Carnelley in 188[illegible] (Brit Assoc Reports) brought forward the idea that the elements are not elements in the strict sense of the term but are in fact compound radicals made up of at least two simple elements A and B The element A was supposed to be identical with carbon while to B was assigned a negative weight 2 and it was suggested that it might be the ether of space C S Palmer (Proc Colorado Scient Soc) assumed the existence of two sub-elements to which he gave the names kalidium and oxidium and his views appear to have a general resemblance to the hypothesis suggested in the text The original article is abstracted in Venable's Periodic Law and is referred to in footnotes in Palmer's translation of Nernst's Theoretical Chemistry

† It may also perhaps be worthy of note that Mr Egerton's calculations (*loc cit*) lead him to postulate an element of nearly this atomic weight namely 2 9844 although his paper gives no indication as to its character

ELEVATORS

At Hamburg there has been recently constructed a tunnel which runs under an arm of the Elbe River and it thus serves to connect two different quarters of the city. The tunnel is formed of two parallel tubes placed nearly horizontal and having [illegible] meters ([illegible] feet) diameter. A point which is worthy of notice here is that vertical shafts and elevators are used at the ends of the tunnel in place of the usual inclined [illegible]. There are used two shafts of [illegible] meters ([illegible] feet) diameter and about [illegible] meters ([illegible] feet) in depth. In each of these shafts there is a stairway, and also six [illegible] of [illegible] feet [illegible] are placed in the middle of the shaft and are designed to take a load of 10 tons. These serve to lift the heavy vehicles, while there are also provided two small elevators of the [illegible] type. [illegible] elevator cabin is balanced at half the normal load by a counterweight so that the motor is designed [illegible] to lift the additional half load. Direct current electric motors are used here, and each of the large elevators has two motors, while one motor serves for the small ones. [illegible] the [illegible] all [illegible] by means of [illegible] [illegible] motors have different field windings, and the results of these different [illegible] are combined in different ways according to the working of the elevator, starting, braking, etc., by an automatic [illegible] system. A well designed set of safety appliances completes the apparatus.

ALCOHOL IN INTERNAL COMBUSTION ENGINES

A paper recently read before the Canadian Society of Civil Engineers by G. [illegible] Cuillet on the use of alcohol in internal combustion engines. From this paper we gather that although methyl alcohol (CH_3OH) has a heat of combustion of only 10,000 B.Th.U. per lb. or [illegible] kg. cals. per kg., against gasoline (or coal oil) at [illegible] B.Th.U. per lb. or 10,[illegible] kg. cals. per kg., yet for complete combustion 1 kg. alcohol requires only [illegible] cu. m. of air, while 1 kg. gasoline requires [illegible] cu. m. This enables an engine cylinder of fixed dimensions, say 10 liters, to develop more power from alcohol. Thus in 10 liters of air we can burn [illegible] gm. alcohol or [illegible] gm. gasoline, and the heat generated would be for alcohol [illegible] (1000 [illegible]) = [illegible] kg.-cals., for gasoline [illegible] (10 [illegible] 1000) = [illegible] kg.-cals. The vapor pressures of these liquids throw light upon the question of their vaporization or comparative facility for being carbureted. In the following table the figures for gasoline are approximately correct on account of variation in quality. Ethyl alcohol (C_2H_5OH) is added for comparison.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]
[illegible]	[illegible]			1
[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]			[illegible]
[illegible]		[illegible]		411
[illegible]	[illegible]	[illegible]	[illegible]	18

The engine used was a Blackstone oil engine rated at 4 horse-power with [illegible] in. diameter of cylinder, 10.[illegible] in. stroke, running at [illegible]60 revolutions per minute, installed in the Mechanical Laboratory at McGill University. For oil fuel the engine had hot-tube ignition, hit and miss regulation with centrifugal governor and a screw adjustment for regulating gas valve lift, by which the quantity of fuel was determined. For alcohol electric sparking plug ignition, the plug being placed in the current of the gases to the cylinder, was substituted, and a larger fuel nozzle with needle valve adjustment was supplied. Brake tests were made with prime Canadian white oil having calorific value of 19,[illegible]00 B.Th.U. per lb. on the higher scale and 18,[illegible]00 B.Th.U. per lb. on the lower, and having a sp. gr. of 0.802. Wood alcohol of [illegible] sp. gr. gave by Junker calorimeter [illegible]00 B.Th.U. and [illegible]00 B.Th.U. per lb. on the higher and lower scales, and denatured or methylated spirit of [illegible] per cent pure alcohol and 0.817 sp. gr. gave 10,[illegible] B.Th.U. and [illegible]00 B.Th.U. per lb. on higher and lower calorific values. Numerous tests were made with these fuels, the results of which are set out in two long tables and many indicator diagrams.

Curves show that the engine used over double the weight of alcohol compared with coal oil for the same brake horse-power, thus making fuel consumptions for equal overall thermal efficiencies in the same ratio. Slightly less power was obtained with alcohol on full load. Igniter and vaporizers worked quite satisfactorily, but the air valve had to be kept almost wholly closed. The engine would not run properly on methylated spirit. The chief drawback to alcohol as a fuel is its comparative cost where duty is charged

ENGINEERING NOTES.

The increasing interest in the mineral products of the Western States, especially those lying in or west of what may be broadly termed the Rocky Mountain region, is reflected in the large measure of attention given to that region by the Geological Survey, which for several years has issued under the title "Contributions to economic geology" annual volumes devoted largely to the mineral resources of that part of the country. The latest volume of this series (Bulletin 380) contains a number of valuable papers discussing gold, silver, cement, and iron in Colorado; gold, silver, copper, and asphaltite in Nevada; gold and silver in Oregon; lead, zinc, and iron in New Mexico; wolframite and marble in Arizona, and other lesser deposits.

Paris stands 2[illegible]0 miles above the mouth of the Seine, measured along its course, and the area drained by the river above the city is only about 17,[illegible]00 square miles. The mean discharge of the Seine at Paris is about 9,000 cubic feet per second (or, as engineers phrase it, "second-feet"); its greatest discharge in the flood of 18[illegible] was [illegible]8,[illegible]00 second-feet. Its discharge at the height of the recent flood (January [illegible]th, 1910) is reported to have been 8[illegible],[illegible]00 second-feet. This is less than one-eighth the flood flow of the Susquehanna in 188[illegible] ([illegible]0,000 second-feet) and less than one-fifth the flood flow of the Potomac at Washington in the same year (470,000 second-feet), when boats were paddled along Pennsylvania Avenue in the heart of the city.

A contribution to the study of phosphor bronze has been made by O. F. Hudson and F. F. Law. They point out that in alloys containing less than about [illegible] per cent of tin the phosphorus is present as rounded, more or less detached particles of copper phosphide CuP, the tin being in solution in the copper. With more than about 1[illegible] per cent of tin the alloys contain in addition a ternary eutectic of copper, CuP and CuSn, which has the composition 81 per cent of copper, 1[illegible] per cent of tin and [illegible].8 per cent of phosphorus, its melting point being 6[illegible]0 deg. C. Copper is capable of holding a small quantity of phosphorus as tin in solution, and in the malleable phosphor bronzes, in which tin does not exceed about 6 per cent and phosphorus 0.[illegible] per cent, the phosphorus is present mainly in this state. In the cast phosphor bronzes, which may contain as much as 12 per cent of tin and 1.[illegible] per cent of phosphorus, the ternary eutectic is an essential constituent.

Some of the Paris newspapers have deplored what they have called the exaggerated foreign accounts of the flood, but no complete or trustworthy estimate of the damage done has yet been made. The Economiste Français says: "It is desirable to challenge many of the statements that have appeared to the effect that the national wealth has been seriously diminished and that it will be necessary to contract large public loans to cover the expenditures involved." M. René Taveruier, engineer of the French Department of Public Works (Ponts et Chaussées), writes to M. O. Leighton, chief hydrographer of the Geological Survey: "No bridge has been seriously damaged. The underground works, the sewers and the tunnels of the Metropolitan Railway, have in general withstood the flood perfectly despite the abnormal pressure to which they have been subjected by the encroachment of the water. The damage, so far as public works are concerned, affects principally the docks, excavations, and unfinished works." The details of the several projects proposed to prevent future overflows of the Seine at Paris will be studied with general interest when they become available.

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TRADE NOTES AND FORMULÆ.

Chocolate and Marzipan (Marchpan) Glaze.—For coating chocolates and marzipan so-called "confectioners' varnish" is usually employed. It is made from gum sandarac 125 parts, benzoin 125 parts, Venice turpentine 10 parts, and alcohol 740 parts.

Cedar Wood Odor Imitated.—Sandal oil is dissolved in absolute or strong alcohol, and with the solution a wood resembling cedar in grain, such as willow or poplar, is painted or saturated. Finally a little Vesuvine (Bismarck brown) may be added.

For Preparing Celluloid Dishes.—A mixture of 3 parts of alcohol and 4 parts of ether is recommended. The fracture surfaces are painted with this and on softening are pressed together. The same purpose according to another recipe by L. E. Andrés is effected by the following solutions: 1 part camphor, 5 parts shellac, 20 parts alcohol; or 1 part camphor, 15 part shellac, and [illegible]0 parts alcohol.

Glazing for Bottle Tops.—A bottle lac of this description is made simply by melting 1 part shellac, taking it from the fire and stirring in, for red 2/5 part red lead, for green 1/4 part Russian green, yellow 1/[illegible] part chrome yellow, blue 1/2 part ultramarine blue. In the mixture while hot the bottle tops are quickly dipped, regularly turned, and a fine brilliant coating is obtained, using very little.

White Cement (according to O. Fahnejelm): 75 parts pure washed chalk and 25 parts of washed kaolin calcined at a bright red heat and afterward ground give a snow-white powder. This cement alone or mixed with a small percentage of gypsum makes an excellent hydraulic mortar, which hardens under water and after seven days attains a solidity of 6 to 10 kilos to 1 square centimeter. After three months it shows a strength of 2[illegible] kilos per square centimeter.

Pompeian Mosaic may be imitated with the aid of metallic cements made from zinc compounds, lead oxide, magnesia cement, etc. The cement is prepared in the form of a thin paste and mixed with fragments of marble, lapis lazuli, malachite, etc., in the proportion of 1 to 1 1/2 to 20. To the roughened moistened surface one color adjoining the other is applied according to the pattern, and the whole placed under pressure. The hardened surface is cut and polished. The outlines of decorations may be reserved with stencils and then inlaid.

Chartreuse Liqueur (according to French directions):

	Green Parts	Yellow Parts	White Parts
Iva herb	2[illegible]0	125	125
Aloe		25	
Angelica seed	12	125	125
Angelica root	60	12	30
Arnica blossoms	1	1	
Balsamite balsam	1[illegible]0		
Calamus			30
Ceylon cinnamon	1	1	100
Cardamoms, Malabar		30	30
Coriander		1,000	
Tonka bean			10
Cloves		1	30
Hyssop	[illegible]00	1[illegible]0	1[illegible]
Mace	20	1	30
Nutmeg			15
Poplar buds	[illegible]0		
Common balm	[illegible]00	250	125
Peppermint	250		
Thyme	30		

Digest for 24 to 36 hours with 10,000 parts 95 per cent alcohol and 5,000 parts of water. Then distill off as much as possible and again rectify the distillate. The green and yellow Chartreuse are kept at an alcoholic strength of about 40 per cent by adding to the distillate 33,000 parts of best (85 per cent) alcohol. Sweeten with 25,000 parts of boiled sugar and make up with water to 100,000 parts. White Chartreuse is kept at about 45 per cent by adding 37,000 parts of 95 per cent alcohol, sweetening with 35,000 parts of sugar and making up to 100,000 parts.

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THE SIXTY-INCH REFLECTOR OF THE MOUNT WILSON SOLAR OBSERVATORY *

By E. A. Fath

The new sixty-inch reflecting telescope of the Mount Wilson Solar Observatory has been in operation for about one year. It is primarily a reflector of the Newtonian type with an aperture of sixty inches and a focal length of twenty-five feet. The outer section of the tube carrying the Newtonian plane mirror can be replaced by similar sections carrying convex mirrors which reflect the cone of light back toward the large mirror. Then by introducing a plane mirror in the path of the beam near the lower end of the tube to throw the beam out to the side it is possible to obtain equivalent focal lengths of 80, 100 or 1[illegible]0 feet. For direct photography either the [illegible] or 100-foot focus is used; for spectrographic work the 2[illegible], 80 or 1[illegible]0 foot combinations are available.

The steel tube is of skeleton construction, exceedingly rigid and weighs only four tons. It is carried by a massive fork at the upper end of the polar axis. Most of the weight is taken off the bearings of this axis by means of an iron float fastened to it and buoyed up by mercury. The moving parts of the telescope weigh about twenty-three tons.

The driving clock which stands six feet high is of the Warner & Swasey type, such as is used for the Yerkes and Lick refractors. There is, however, one important modification. Instead of the governor being connected with the driving shaft by means of the ordinary system of gears it is mounted directly through a small [illegible]. The weight for the clock consists of sixty cast-iron disks each weighing about one hundred pounds. The winding of the clock is automatic. When the weight is nearly down it closes a circuit and an electric motor then winds it up. When the weight has reached the proper height it breaks the motor circuit. The clock thus needs no attention throughout the night. The large worm gear which rotates the telescope is ten feet in diameter. When properly rated the clock runs very accurately. Frequently the guiding star will remain on the cross wires of the guiding eyepiece for five minutes at a time.

The optical properties of the large mirror are of

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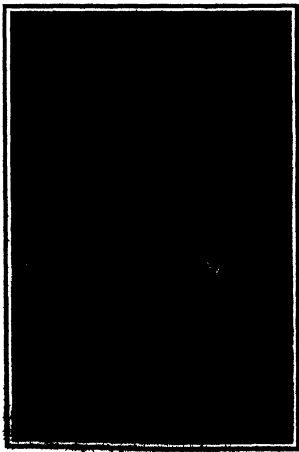
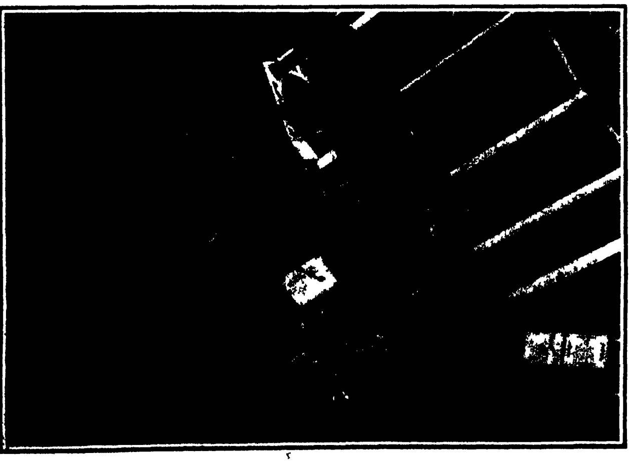
* Popular Astronomy

STEEL BUILDING AND DOME FOR USE OF SIXTY INCH REFLECTOR

SIXTY INCH REFLECTOR MOUNTING IN DOME



SIXTY-INCH REFLECTOR MOUNTING IN ERECTING SHOP



DOUBLE SLIDE PLATE-CARRIER IN PRINCIPAL FOCUS OF SIXTY INCH REFLECTOR

THE SIXTY-INCH REFLECTOR OF THE MOUNT WILSON SOLAR OBSERVATORY the highest order The surface is correct to about 0.00000 of an inch This is 1/10 the wave length of sodium light Under good atmospheric conditions star images measuring only 1.2 inches in diameter have been obtained on Seed 27 plates with exposures up to two hours in length

The building and dome are built of steel throughout and rest on a concrete foundation The walls are double with an air space of two feet between them and so arranged to permit a free circulation of air The dome which is fifty eight feet in diameter is covered except in winter with white canvas about two feet above the metal surface It is found that in the summer this simple device to prevent the sun shining directly on the dome cuts in two the daily range of temperature within

The building has two floors the lower at the ground level and the other the operating floor nineteen feet above this The former is of cement and the latter of thin steel plates The opening in the dome is sixteen feet wide the shutter running back over the dome instead of opening to the side as in the usual type The observing at the primary focus is done from a movable platform that can be raised or lowered along the curve of the dome opening Electric motors are used for all movements of the telescope dome and observing platform

The changes of temperature referred to above have an appreciable effect on the performance of the telescope owing to the changes in the focal setting as the tube cools during the night With the canvas cover over the dome this amounted to only 0.04 of an inch during the average night This however was still too great especially for long exposures running over several hours In order to further decrease the effect an insulating chamber of woolen blankets was made to be placed over the lower half of the tube the mirror the float etc Radiation from the floor is prevented by mats of the same material The opening in the tube where the covering surrounds it is closed by a tight fitting wooden cover lined with felt Under average conditions the daily range of temperature within the cover has been reduced to 2 deg Centigrade (3.6 Fahrenheit) This in turn has reduced the change of focal setting to 0.02 of an inch During long exposures the plate can be removed and the focus corrected at intervals so that the plate is never out of focus by more than one or two thousandths of an inch The method of focusing is simple A carefully ground knife edge is placed across the center of the field and the image of a star at the center examined just as an artificial star image is examined in the optical shop When the knife edge is at the focus of the mirror and is moved across the cone of rays, it causes the mirror to darken uniformly over its whole surface until all the light is cut off This test is visual the eye being placed close to the knife edge By this method the focus can be determined with an accuracy of about 1/1000 of an inch in a minute or two

A great variety of work is being undertaken with this telescope At present it is being used for the photography of nebulæ and star clusters, the photography and spectrographic work on all the regions that can be reached that are included in Kapteyn's 'Plan of Selected Areas', spectrographic work on the brighter stars star clusters and nebulæ and photometric work of various kinds

Mr Ritchey, who ground and figured the large mirror and designed the dome and mounting is to be congratulated on the success he has achieved in completing such a great instrument and we look forward to the day when the contemplated 100 inch reflector will be completed in the hope that it will prove even better than the sixty inch

SVEN HEDIN'S "TRANS-HIMALAYA."*

DISCOVERIES AND ADVENTURES IN TIBET.

The special quest of Dr Sven Hedin in his last and greatest journey of geographical exploration in Tibet was that hitherto unexplored range of mountains which was believed to rise within the unsurveyed white patch entered on the Roof of the World to the further side of the Tsangpo or Brahmaputra behind the Himalayas Although this immense chain stretching for about 1000 miles is one of the mighty mountain ranges of the earth and forms the northern watershed of the great Brahmaputra as well as of the Upper Indus yet its very existence, even was largely the subject of conjecture

A line of high peaks in this desolate region was first reported about 200 years ago by a party of surveyor Lamas who had been trained and sent out into Tibet by the Jesuits of Peking under the patronage of the Emperor Kang hsi and the peaks as located and named by these Tibetans and rediscovered by recent travelers figure on the rough map published by D'Anville in A D 1733 Brian Hodgson in 1848 as the result of his inquiries in Nepal depicted these peaks in his sketch map as forming portions of a hypothetical range of mountains stretching continuously from the Karakorum and Pamirs on the west to the Tengri Nor Lake near Lhasa on the southeast and he assigned to it the name of Nyenchen after the name of the highest peak near its Lhasa end In the map attached to Huc's travels this range is also represented as an unbroken chain and so too in Saunders's map of 1874 in Markham's Tibet while Grenard the companion of the ill fated de Rhins in 1809 indicates it conjecturally as a double range which Col Burrard of the Indian survey in his recent book on the geography of Tibet has called the Kailas Range after the famous Mount Olympus of the Hindus at its northern end So great indeed was the need for the exploration of these mountains deemed to be that the president of the Royal Geographical Society declared a few years ago that In the whole length from the Tengri Nor to the Mariam La no one has crossed them so far as we know (a statement by the way not absolutely correct as the pundits Nain Sing and A K and Littledale had crossed them)

I believe nothing in Asia is of greater geographical importance than the exploration of this range of mountains

This then is the range to which Dr Hedin now assigns the appropriate name of Trans Himalaya after having zigzagged across it by eight different passes and after mapping out its contour in considerable detail

More than this the two handsome volumes in which Dr Hedin tells the story of this great achievement differ from all his previous books on the Forbidden Land in possessing greater human and living interest For the first time after his many previous years of travel in that country he has been able to penetrate beyond the desolate deserts and reach a portion of what he truly terms Tibet proper that is the part chiefly inhabited by a settled population" For this good fortune and for the more friendly treatment generally which he experienced at the hands of the Tibetans he is indebted directly to the amicable relations established with Tibet by the British mission of 1904 none the less real and genuine though cultivated at the point of the bayonet These relations of friendship and respect strengthened and cemented by the visit of the Grand Tashi Lama to India in 1905 to meet the Prince of Wales have enormously increased the prestige of the European throughout Tibet and Central Asia Thus a section of Younghusband's mission with four British officers unaccompanied by any escort of their own but relying solely on the protection of the Tibetans was able to pass in a friendly way through those inhabited districts of Tibet two years before Dr Hedin visited them and several other Europeans have visited the Tashi Lama's palace and the western capital In particular Lord Minto the Viceroy of India to whom the author gratefully dedicates his book used his influence with the Tashi Lama so that many doors in the forbidden land formerly tightly closed were opened to me

The start under such favorable conditions was made in August 1906 from Ladak by way of Kashmir as the recent treaty with China absolutely prohibited Europeans entering Tibet across the Indian frontier and could not be relaxed by the Indian Government even in favor of Dr Hedin much to his freely expressed vexation He gave out that he was proceeding to Turkestan but in the solitudes a few marches out of Leh he crossed the lofty Karakorum range and turned southward into the great elevated Tibetan desert the Chang tang Here he pushed on through the stark solitudes day after day for two months surveying the country without meeting a soul until he crossed the Trans Himalaya near the capital of Western Tibet The first nomadic herdsmen he encountered were friendly and acted as guides and supplied provisions and baggage animals They as well as their chief informed him of the friendly passage that way of the British officers saying that now Europeans seem to be privileged to pass through the country In a few days more Tibetan couriers arrived with his European letters which had been sent on by the British agent through the Tashi Lama at the request of Lord Minto and accompanying these letters were welcome stores of European provisions newspapers books etc as presents from the British agent at Gyantse and most important of all an official to guide and assist Dr Hedin through that inhabited portion of Tibet to the Tashi Lama's capital

Thereafter writes our author the route was as free to us as the uninhabited Chang tung had been We should pass black tents daily be able to buy all we want We enjoyed unlimited freedom and had not a single man with us as escort or watchman Arrived at the capital Shigatse he says the priests welcome us with kindly good tempered smiles and he was installed as the favored guest of the Tashi Lama the second of the 'Living Buddhas' who received him cordially several times This high honor which he procured through Lord Minto, proved so invaluable to Dr Hedin that as he writes, "eighteen months later it came about that chiefs and monks said Bonpo Chimbo (great lord') we know that you are a friend of the Tashi Lama and we are at your service!" His Holiness it is interesting to learn has been a keen photographer since his visit to India, when he was initiated into the mysteries of the art by British officers In his palace he has had a dark room fitted up where the developing is done by one of the young priests who accompanied him to India While halting at the Tashi Lama's capital our traveler lightened his baggage by sending back to Europe through the British officer at Gyantse his survey records note books photographic plates rock specimens etc Here also he witnessed the new year's carnival and festivities and was allowed to roam freely over the famous palace of the monastery of the Tashi Lama a busy hive of four thousand ascetics but unfortunately our author through want of special knowledge has not added anything to our information on these interesting subjects

His stay at Tashilhunpo was brought suddenly to an end by the Chinese officials at Lhasa who insisted on the Tibetans enforcing the treaty so that Dr Hedin was compelled to return forthwith to Ladak under a guard On the way he succeeded in eluding his guard and made a detour across the Trans Himalaya by two fresh passes he also discovered a new western source of the Brahmaputra and took a series of soundings over Lake Manasarowar by means of his portable boat

On return to Ladak with characteristic pertinacity he decided to make a second expedition back again to Tibet in order to complete his partial exploration of the Trans Himalaya as he reflected that it was especially irritating to think that others might come here and rob me of these conquests So with a fresh caravan got together with the aid of the British officials he plunged south once more through the terrible Tibetan deserts and much astonished the discomfited Tibetan chiefs by his reappearance among them a year after they had got rid of him with such infinite pains In this latter traverse three more passes were surveyed with the result to quote the author's own words that When I passed over the Trans Himalaya for the eighth time at Surnge la I had the satisfaction of seeing all the old hypotheses fall down like a house of cards and a new ground plan laid down on the map of Asia where before the blank patch yawned with its alluring Unexplored This mountain system it is remarked cannot be called a range' because it is a collection of several ranges more or less parallel or branching off at various angles Dr Hedin however will find that somewhat similar features are displayed by the Himalayas themselves

The narrative of the two years strenuous journeyings for the survey of these formidable mountains is written in a vigorous, direct style which reflects the cheery optimism of this pioneer traveler as he pushed on undaunted in the face of endless hardships and difficulties It also shows him animating his men with something of his own abounding enthusiasm, without which indeed the exploration could never have been accomplished The reader feels the swing of the caravan moving through the pages with the thrill of reality and a pervading sense of danger ahead, though to many readers the repetition from day to day of the details of camp routine, and the reiterated records of the grim struggles of the men and the sufferings and painful deaths of the dwindling baggage animals, will doubtless make somewhat monotonous and unpleasant reading after a time

Besides the geographical record, so important in itself, and the camp episodes, there is little else that is new. Remarkably few references occur in respect to natural history, scarcely any mention or passing recognition is made of wild animals or plants, or minerals such as we expect in the journal of a scientific traveler, and the few remarks which occur in regard to the people and their customs exhibit a lack of familiarity with authentic sources of precise information and the well-known researches of Rockhill and others. Incidental reference is made to a collection of rock specimens, the description of which by specialists is promised along with the detailed maps which will doubtless be accompanied by an analysis of other objects collected, though no mention is made of them. The young Indian elephant of the Tashi Lama, we are told, is the only one of his species in the whole country, but the Talai Lama, we know, has (or had in 1904) a much larger tusker, a present from the Sikhim raja, which had survived the arctic winters of many years at Lhasa and was housed in a grove near the British mission camp outside that city in 1904. 'A *Bod* or Buddhist' is spoken of as if the two terms were equivalent, whereas the former means a Tibetan or inhabitant of *Bod* or Tibet. The *Bothiyas* (sic) are described as a mixed people sprung partly from Indian and partly from Tibetan elements, whilst in reality Bothiya is merely the Indian designation of the Tibetan race or people of *Bod*. A want of precision in the spelling of several of the vernacular place-names is noticeable in a professedly geographical work, thus Sekiya invariably occurs in the text for the well-known monastery and sect of Sakya or Saskyas and Yeretsangpo for the Yaru (or upper) Tsangpo, and many of the names are spelt phonetically according to no regular system. To say 'Hor or Bod-yul' is equivalent to saying 'Turkish or Tibet.' In regard to the term used for the great Manasarowar Lake by D'Anville in his old map, namely *Mapama Talai* or Mapama Lake, Dr. Hedin gives Mavang as the correct form, but this latter is merely the vulgar vocalization of the name which is spelt and properly pronounced as *Mapham*, and our author sagely states that D'Anville might have added that the Chinese Talai or Dalai means ocean, and that it was used to imply that this particular lake was larger than the other neighboring lakes mentioned in his text. This, however, is not correct. Talai is *not* Chinese, but a Mongol word, and it is applied to all the lakes in that neighborhood as well as throughout the Northern Himalayas irrespective of their size, and in the abbreviated form of *Tal* it was imported into Northern India by the Moghal section of the Mongols and is now naturalized there as the current vernacular name for a lake. Deficiencies of this kind, however, can be corrected in another edition and in no wise belittle the outstanding importance of Dr. Hedin's splendid geographical achievements.

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* Trans-Himalaya, Discoveries and Adventures in Tibet By Sven Hedin With 388 illustrations from photographs water-color sketches and drawings by the author and ten maps In two volumes Vol I pp xxiii 436 vol II pp xvii + 441 (London Macmillan & Co Ltd 1909)

These attractive volumes, with their wealth of sketches and beautiful photographs, deserve nothing but praise and form a fitting record of Sir Sven Hedin's magnificent pioneer work amongst one of the most forbidding mountain ranges in the world. This work too is of such importance to Indian hydrography as to have gained for its author amongst other well-earned honors a knighthood of the Indian Empire. It is also pleasing to observe that his men have not been forgotten, for the thirty-seven Asiatics who followed the explorer faithfully through Tibet, and, as the author generously admits, contributed in no small degree to the successful issue and results of the expedition, have been rewarded with gold and silver medals bestowed by the King of Sweden.—Nature.

HALLEY ON THE AGE OF THE OCEAN.

CHEMICAL DENUDATION IN RELATION TO GEOLOGICAL TIME.

BY GEORGE F. BECKER

Edmund Halley was a very great man. He was not only the first to predict correctly the return of a comet, that which is now known by his name, but also, before Newton had announced his results to any one, arrived at the conclusion that the attraction of gravitation probably varied inversely as the square of the distance. While these and other important achievements of his are well known, it seems to have been forgotten that Halley devised a method of determining the age of the ocean from chemical denudation. Indeed I find no mention of Halley in the indices of some of the most authoritative works on geology and geochemistry, while it is evident that neither Mr. T. Mellard Reade[*] nor Mr. J. Joly[†] was aware of a predecessor in this important field. It was almost by accident that I came across Halley's paper, read before the Royal Society in 1715, extracts from which are given below.

Halley recognized that the method as he proposed it was almost impracticable, but writing as he did twenty-eight years before Lavoisier's birth, he could hardly have guessed that accurate analyses of river waters, whose solvent action he so clearly describes, would ever become not merely possible but easy. It is very interesting to note that Halley's reasoning is strictly uniformitarian, while he recognized the tendency involved to a maximum estimate.

Subject to this same limitation (extended to other features besides an original saltness of the sea) Mr. Joly's method of determining the rate at which the accumulation of salt in the ocean takes place from the analysis of river waters is perhaps the most important means now available for an estimate of the antiquity of the stratified rocks, because it is the simplest and least open to question. To my thinking the fact that his train of reasoning coincided with that of the great astronomer only adds to the credit due Mr. Joly.

A great amount of work has been done of late years on the composition of river waters, much of it incited by Mr. Joly's memoir and undertaken with the purpose of improving the data for such a determination of the age of the ocean. Within a few months it will be practicable to make known the results of a revised estimate founded upon data far more ample than those at the disposition of Mr. Joly eleven years ago. Mr. F. W. Clarke is now engaged in preparing this estimate.

The subjoined extracts from Halley's paper[‡] cannot but interest all lovers of natural science.

On the Cause of the Saltness of the Ocean, and of the Several Lakes that Emit no Rivers; with a Proposal, by Means Thereof, to Discover the Age of the World.

"There have been many attempts made and proposals offered to ascertain from the appearances of nature, what may have been the antiquity of this globe of earth, on which, by the evidence of sacred writ, mankind has dwelt about 6,000 years, or according to the Septuagint above 7,000. . . . This inquiry seeming to me well to deserve consideration and worthy the thoughts of the Royal Society, I shall take leave to propose an expedient for determining the age of the world by a medium, as I take it, wholly new, and which in my opinion seems to promise success, though the event cannot be judged of till after a long period of time; submitting the same to their better judgment. What suggested this notion was an observation I had made, that all the lakes in the world, properly so called, are found to be salt, some more some less than the ocean, which in the present case may also be esteemed a lake, since by that term I mean such standing waters as perpetually receive rivers running into them, and have no exit or evacuation.

"Now I conceive that as all these lakes receive rivers and have no exit or discharge, so it will be necessary that their waters rise and cover the land until such time as their surfaces are sufficiently extended so as to exhale in vapor that water which is poured in by the rivers, and consequently that lakes must be larger or smaller according to the quantity of the fresh they receive. But the vapors thus exhaled are perfectly fresh, so that the saline particles brought in by the rivers remain behind, while the fresh evaporates; and hence it is evident that the salt in the lakes will be continually augmented, and the water grow salter and salter.

"Now if this be the true reason of the saltness of these lakes, it is not improbable but that the ocean itself is become salt from the same cause, and we are thereby furnished with an argument for estimating the duration of all things from an observation of the increment of saltness *in their waters*. For if it be observed what quantity of salt is at present contained in a certain weight of the water of the Caspian Sea, for example, taken at a certain place in the driest weather; and after some centuries of years the same weight of water, taken in the same place and under the same circumstances, be found to contain a sensibly greater quantity of salt than at the time of the first experiment, we may by the rule of proportion make an estimate of the whole time wherein the water would acquire its present degree of saltness.

"And this argument would be the more conclusive if by a like experiment a similar increase in the saltness of the ocean should be observed, for that after the same manner as aforesaid receives innumerable rivers, all which deposit their saline particles therein, and are again supplied, as I have elsewhere showed, by the vapors of the ocean, which rise from it in atoms of pure water without the least admixture of salt. But the rivers in their long passage over the earth imbibe some of its saline particles, though in so small a quantity as not to be perceived unless in these their depositories after a long tract of time. And if on repeating the experiment after another equal number of ages it shall be found that the saltness is further increased with the same increment as before, then what is now proposed as hypothetical would appear little less than demonstrative. But since this argument can be of no use to ourselves, it requiring very great intervals of time to come to our conclusion, it were to be wished that the ancient Greek and Latin authors had delivered down to us the degree of the saltness of the sea as it was about *2,000* years ago, for then it cannot be doubted but that the difference between what is now found and what then was, would become very sensible. I recommend it therefore to the society, as opportunity shall offer, to procure the experiments to be made of the present degree of saltness of the ocean and of as many of these lakes as can be come at, that they may stand upon record for the benefit of future ages.

"If it be objected that the water of the ocean and perhaps of some of these lakes might at the first beginning of things in some measure contain salt, so as to disturb the proportionality of the increase of saltness in them, I will not dispute it, but shall observe that such a supposition would by so much contract the age of the world within the date to be derived from the foregoing argument, which is chiefly intended to refute the ancient notion some have of late entertained of the eternity of all things; though perhaps by it the world may be found much older than many have hitherto imagined."

The Boston Elevated Railway Company has begun to hold regular monthly meetings of the chief engineers of its power stations corresponding to the meetings which the company also holds with its division superintendents and car-house foremen. It is proposed to appoint subjects for discussion which will lead toward a reduction in operating costs and the improvement of the power station service in general. Tabulations of the cost of production at the different plants will be prepared regularly, including comparisons of the current performance of each station with previous operation and the contrasting of conditions and operating results in the several plants. The company at present operates eight steam and two gas engine plants of a normal capacity of [illegible]0,000 kilowatts. The operations of these stations are under the jurisdiction of a superintendent of power stations, reporting to the chief engineer of motive power and rolling stock. At the initial meeting in April a general discussion of operating conditions in the different plants was held, after which the purpose of the meetings was explained by the chief engineer of motive power and rolling stock.

The purchase of coal on its heating value by the United States government is reported by the Technologic Branch of the United States Geological Survey to have effected a saving of $200,000 in the annual fuel bill of the government, which now aggregates about $1,000,000. At the present time forty departmental buildings in Washington, more than three hundred public buildings throughout the United States, the Panama Railway, navy yards and arsenals are buying their fuel supplies on specifications fixing the amount of ash and moisture. The actual quality and value of the coal delivered is determined by analyses of representative samples, and deductions are made from the contract price in case of deliveries of poor coal proportionate to the decrease in heating value. Premiums are paid for any decrease of ash greater than 2 per cent below the specified amount at a rate of 1 cent per ton for each per cent, and deductions are made at an increasing rate for each per cent of ash in excess of 2 per cent above the standard.

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[*] "Chemical Denudation in Relation to Geological Time," 1879.

[†] Trans. R. S. Dublin, vol. i., 1899, p. 23.

[‡] Phil. Trans., vol. xxix., 1715, p. 296.

THE ANCIENT AND THE MODERN ABACUS.

THE OLDEST COUNTING MACHINE.

BY DANIEL ARTHUR.

The ancient decimal bead frame is still in actual use side by side with the very latest adding and listing machine, which we might call a modernized abacus. This modern decimal calculator with its printing press attachment and its electrical power plant almost thinks, yet it is fundamentally the same as the Japanese "Soroban," the Roman Abacus and the Chinese "Swan Pan" (sometimes called "So Pan"). Abacus meant originally a sort of table, bench or board. Then it became a game board ruled off in squares on which disks were moved, giving them value of location. Swan Pan in its abbreviated derivation literally means playing the bamboo. "Swan" stands for bamboo and "Pan" means play. The name seems to have developed quite naturally, as the little rods on which the balls or beads slide are made from young bamboo stems. Perhaps if our Western ear could catch the sweet commercial music of the clicking balls with the exact sensations recorded through the oriental ear, we would come nearer to the full understanding of industrial peace.

The Swan Pan is of various widths, some having few and others many bamboo rods. The more numerous they are the greater the capacity of the frame. Fig. 1 shows a fifteen rod or fifteen place Swan Pan which is about an average size for general use. The highest whole number that can be set on this one is [illegible]. In this illustration the single counter moved up to the cross bar is the only bead which stands for anything, all the other fourteen rods or columns are set blank or assumed ciphers. This one bead means one hundred trillions in its full value sense. The Swan Pan is quite frequently confounded with the bead frames used in our primary schools. This is a gigantic blunder, as the former is a mathematical device of almost unlimited range, while the latter is an aid in teaching children to count.

Fig. 2 illustrates some of the steps of centuries or the evolution from the counting tools of nature (hands) to this Swan Pan, which still survives and which is the parent of the complex machines of to-day.

Before proceeding, however, it might be well to correct another more or less popular error, that of calling the fingers the origin of the number concept. This is not the case.

In fact man was well advanced in the world before he could conceive of a number as great as the count of one of his hands. Prof. Conant in his very complete work on the origin of number words brings this point out very clearly. He shows that the number concept began with one. Then the mind grasped something like one and two. Names were given to as small a radix as this, names which translate into "one" and "many." He shows that some savage tribes do not use names for numbers above three. All this goes to show that man was well advanced in the world before he could master counting tools as complicated as his hands. Hands and feet count or scores coming much later. This early development of number concept (less than [illegible] 10) is mentioned here only to show that it is an extensive study in itself. The object of this article is to connect the hand symbols with the "Swan Pan" and the "Swan Pan" with the modern complex machine, and then to show that all three of these methods are in use to-day in our large cities for the transaction of regular business.

The first column in Fig. 2 illustrates the early self-evident symbol hand count, and to avoid complication we will not go into too much detail, such as different number meanings indicated by clapping the hands, or holding them in vertical or horizontal position or upside down, touching certain joints in the fingers, etc. These varieties would fill a book. We take the simple horizontal form which makes the forefinger of the left hand stand for one. The second column shows the natural word meaning of these symbols. Many early peoples gave names to decimal numbers which were actual descriptions of the finger operations. For example, Prof. Conant draws our attention to the Eskimos of Point Barrow. Their name for seven is "Twice on the next." Six is named "Five and one on the next." Another tribe gives the name "Double finger" to the number two; another well advanced tribe has this name for a thousand: "The fingers all the fingers times all the fingers," which is intended to mean 10 times 10 times 10, or 10 x 10 x 10 equals 1,000. These examples will suffice to show that some of the first names given to the hand symbol numbers were literal descriptions of the symbol. One of the involved names was "All but one held up with the rest." This was a name given to nine, which means just the same thing as shown in the primary word column of Fig. 2. The next step after giving a word name to a hand symbol was to construct a condensed and manageable sign for the number, a stroke for every finger or groups of dots like those found on dominoes came first. This was soon found too cumbersome for the larger numbers, so it gave way to a special character or sign for a completed hand and another for two completed hands. The columns marked ancient and modern might more properly be called recent form and present form.

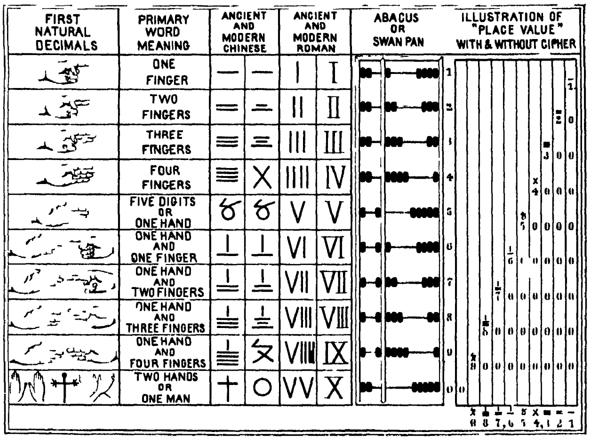


Fig. 2.—SOME STEPS OF CENTURIES IN DECIMAL EVOLUTION.

Let us first refer to the older form of Chinese numbers and note how truly descriptive they are. 1, 2, 3, and 4 are fingers pure and simple. 5 came very naturally. Try it yourself. Just hold up your left hand before you and trace a line down your thumb, then make a circular sweep around the palm and out to the tip of the forefinger. The result is such a perfect Chinese five that it was left unchanged when the last modification took place. For 6, 7, 8 and 9 the completed hand is indicated by a vertical stroke and underscored by the finger strokes, thus making self-evident number signs. Then follows the early form for ten, which is a cross like a crucifix, and is intended to represent a man. The vertical line represents a man's body and the cross bar his outstretched arms. The bar originally terminated in sets of elementary fingers, as shown in the first column. It is interesting to note that this cross is now used in China as one of their words meaning completeness, as well as a sign for number ten. It is also interesting to note that the word "complete" is the name for ten in another part of the world. As ten is such a star number in the decimal system it might be in order to mention some of the many names given to it. Among those are "Half a Score," "Man Without Feet," "One Man of Hands," "One Man," "Double Hand," "All the Fingers," "Finished on Each Side," "Ended Both Hands," "Hand Hand," "Second Hand Fingers," "Two Series," "Second Five," "Half a Man." The last mentioned name for ten is based on the whole man being twenty (hands and feet). When we find a tribe with "one man" as their name for number ten, we are sure this same tribe has no special name for twenty, such as "Score."

Returning to the Chinese numbers, the modern ones, that is to say, those in use to-day for bookkeeping, it will be noticed that numbers 1, 5 and 6 remain unaltered, while 2 and 3 have the stroke lengths varied as shown so as to individualize them. This same change is made on the digit strokes of 7 and 8. Four is changed to a letter X, meaning one hand less one finger. Nine has developed into a combination or composite character made up from 4 and 5, while 10 has become a cipher. This in my opinion is the most important and far reaching step forward ever taken in number construction. It would be impossible to overestimate the value of this gigantic step. The introduction of the cipher or the sign for blank space cleared the track of all obstructions with one sweep, and made our decimal system complete, compact, logical and limitless. The cipher is of course a child of the "Swan Pan," and now that it is in successful operation we can see that an assumed cipher existed on

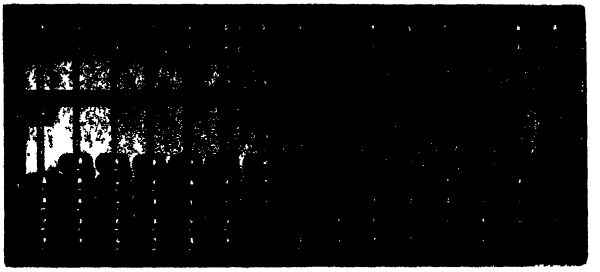


Fig. 1.—CHINESE SWAN PAN SET AT ONE HUNDRED TRILLIONS.

this little frame for centuries before some one knew enough to transfer it to a written record To make this point a little clearer refer to Fig 1 To transfer this one-hundred trillions to a written record the older Chinese method was to write one and follow it with a complicated character which meant hundreds of trillions Its transfer to paper was accomplished by using only two characters one and a qualifier But let us see what happens when a comparatively small but mixed number like 7 426 is transferred from its four decimal columns of the Swan Pan to the account book by the old method Instead of its proper four places it occupies eight places on the book—7 was followed by a character standing for thousands then came 4 followed by the hundreds character then 2 followed by tens and 6 qualified with a unit sign The cipher cured all this long hand complication

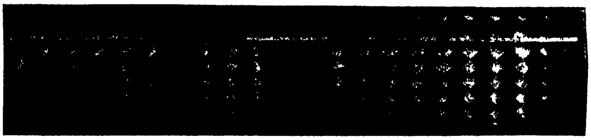


Fig 3 JAPANESE SOROBAN SET AT 100 000 000 000 000 000 000

The evolution of Roman numerals is quite similar to the growth of the Chinese except that hands were held in *vertical instead of horizontal* position I II III IIII being natural vertical finger strokes The V for five (whole hand) being naturally formed by thumb and forefinger A whole hand (V) and one finger (I) for six and a hand (V) and four fingers (IIII) for nine are true nature signs The same remark applies to double V for 10 (VV)

The condensed form now used which is called modern in the illustration converts the double V into the letter X for ten and nine becomes an incomplete example in subtraction X less 1 or 10 less 1 and by the same Roman formula four becomes 5 less 1 Roman numbers have never been written in a strictly decimal order although they are decimally constructed and have been used correctly on the Roman abacus They could be brought into complete decimal order by the use of a cipher but this is now *out of the question* as they are not of a form that admits of rapid work in fact they are kept alive only for dating purposes and the like

The older form of Roman numerals shown here are still to be found on old clocks and calendars and on zodiacs

We now come to the illustration of the Swan Pan (Fig 2) drawn end up for convenience in description (normal position is flat on table or counter as in Fig 1) The drawing shows a ten place frame which is capable of receiving a number as high as 9 999 999 999 The whole number set down by the beads as drawn is 987 654 321 The reason this number is chosen is that it indicates all of the different ball settings (1 to 9) in consecutive order beginning with one *on the top down to nine on the next to lowest rod* The bottom rod is set blank or on cipher If all ten rods were thus set that Swan Pan would be clear of figures and ready for an operator The five balls in the wide compartment are digits while the two balls in the narrow compartment are hands each of which is of course five times the value of a digit ball The Arabic numbers opposite each rod indicate the digital number set on each rod For convenience let us refer to the five balls as fingers and the two balls as hands A finger set against the partition bar counts 1 while a hand set against the bar counts 5 Let us follow the settings as they are 1 finger to bar = 1 2 fingers = 2 3 fingers = 3 4 fingers = 4 1 hand to the bar = 5 1 hand and 1 finger to the bar = 6 1 hand and 2 fingers = 7 1 hand and 3 fingers = 8 1 hand and 4 fingers = 9 Now we could put down 10 by setting two hands to the bar or one hand and 5 fingers but as the decimal place value system prohibits ten on a single rod or column (it being a two place number) we have set it 0 as above This completes the lesson so far as setting down digits is concerned When one grasps the idea properly that the two balls are hands and the five balls are fingers and thumb and that there are no more than ten combinations of these all of which are shown on the frame the matter will seem very simple In other words the operator transfers the hand pictures of the first column to the ten rods of beads

Now we are ready for the next and last step Let us assume that the rods of a "Swan Pan are columns ruled on paper on which we can write numbers We are at liberty to consider all the columns whole numbers beginning with units on the right followed toward the left by tens, hundreds thousands, etc, or we can consider that the two places on the right are units and tens of cents followed toward the left by units and tens of dollars In other words we can divide the columns or rods into whole numbers and decimal fractions and this imaginary decimal point can be placed anywhere we elect We may even divide the Swan Pan and set down two sums using say five rods on one part of the frame to put down $354 26 assuming the decimal point to separate dollars from cents Then on the other end of the frame set down 248 bags of rice or bushels of potatoes On very wide frames of over 20 rods something like the following can be set down 18 pounds of tea at 85 cents per pound equals $15 30 Of course the actual figures set down on the frame would be 18 85 153 The Chinese bookkeeper would know that his first figure meant pounds of tea second figure hundredths of a dollar and that the last figure was his total value or 15 3/10 dollars

In the ten vertical spaces or columns which illustrate the place value of figures set on the Swan Pan in Fig 2 we are assuming that the number is a whole one that *the one finger is a unit the two fingers 20* three fingers 300 and so on making the total 987 654 321 which is given in Chinese numbers at the bottom as well as in Arabic Chinese place value numbers are also shown in the columns above the Arabic

Fig 3 is a reproduction of a Japanese Soroban of 21 rods or columns capable of receiving the almost unthinkable number 999 999 999 999 999 999 999 The Chinese name for a number one tenth the size of this is Woo Leang So or infinite number Sir John Bowring in his book Decimal System tells us that 1 followed by 16 ciphers is called Hang Ho Sa meaning the sands of the Hang River These innocent looking little frames can therefore take care of figures up to the astronomical requirements

On this Japanese Soroban it will be noticed that *there are the same 5 digits in the lower compartment* but only one row of hands in the upper place This is a step in advance of the Chinese as no use of the second row of hands can be made in a strictly decimal operation They might have even gone farther and left off the lowest row of fingers for they are never used in decimal calculations Note that in all the possible settings of the balls as shown in Fig 2 none of the top hands or lower fingers ever leave the outer frame I recently tried an interesting experiment on native Chinese bookkeepers None of them could use the Swan Pan from which I had removed the unnecessary balls but on another where I had locked these two rows with an unseen wire they went through all ordinary operations without discovering the locked balls I might say however that the Chinese use the Swan Pan occasionally for calculations in land measure in which the decimal scale is not used

Fig 4 - SWAN PAN BEAD SETTINGS 1 TO 15 AS USED BY CHINESE LAND SURVEYORS

Fig 4 shows combinations of ball settings from 1 to 15 in which all the balls are used

The use of the Swan Pan in this way is not quite legitimate and the Japanese were a little quicker in seeing this point but did not go quite far enough while they were improving their Soroban The Japanese frame is much smaller and more compact than the Chinese and instead of large cherry shaped beads they use small sharp edged buttons The distance these buttons slide is also much less than Chinese practice It therefore takes sharper eyes to operate and quickly read the Soroban Even with the wide spaces of the Swan Pan the quickness of the native in grasping a large number at a glance is astonishing to the Western observer but with the small buttons and narrow spaces of the Soroban it is still more remarkable The speed of an Eastern expert is almost unbelievable and the percentage of error almost a vanishing quantity In fact it is so unusual for a Chinese bookkeeper to make a mistake on his Swan Pan that his brother Chinaman counts the rare occurrence as an intentional move on his part to deceive I have made many tests of speed between experts on the Swan Pan and experts with pencil and the beads usually won not only on speed but also on accuracy

The short cuts which an expert can use on these little bead frames are many and for certain kinds of decimal problems he can even beat the speed of the very latest adding machine (what I call the modern abacus) In simple sums of addition the modern adding and listing machine is bound to lead in accuracy against the ancient frame for the reason that when the list of items to be added is checked off as the ones intended the footing or sum is bound to be correct unless the machine is broken That is to say the human element is practically eliminated In the case of the Japanese Soroban and the Chinese Swan Pan it is all a question of personal skill These frames are ruled columns so to speak on which decimal sums can be quickly set down or rubbed out Sums can be increased by addition or multiplication or reduced by division or subtraction Each click of a bead means one figure rubbed out and another set down When the last ball of any example is clicked there is nothing more to do this is the answer

In conclusion I would repeat that it would be hard to find a more striking example of the long and useful life of an old invention than the Swan Pan To see it working with its very latest relative (the modern adding and listing machine) speaks volumes regarding the broad difference between the oldest existing empire (China) and the newest power (United States) If the reader wishes to see the original finger abacus still in active use some of the open air markets will best serve the purpose The now famous curb market of New York city is as good an example as any Complicated stock quotations bids and contracts are handled there by finger symbol signs Large figures and fractions are flashed from the street to upper story windows and back again each group of brokers using his own privately constructed code the varieties of which seem almost endless We therefore find the three great stages of decimal development working in harmony in the 1910 A D battle of life

According to the Electrical World during recent tests of wireless telegraphy made with apparatus on board the scout cruisers Salem and Birmingham which were 1 000 miles from each other and 1 000 miles from the high power wireless station at Brant Rock Mass there were serious interruptions in the communications between the two ships and the shore station A fierce storm was raging at the time of the tests and in spite of the interruptions the apparatus was not considered a failure Arrangements are to be discussed with a view to making further tests under more favorable conditions During the next test the ships will be stationed about [illegible] miles from Brant Rock This will necessitate one being near Trinidad and the other 1 000 miles out from the South American coast The most exhaustive test will be the placing of the ships on the African coast 3 000 miles from Brant Rock and 1 000 miles apart If these tests are successful a tower 100 feet higher than the Washington monument which is [illegible] feet in height will be erected in Washington for communication with ships over a distance of 3 000 miles

STORY OF THE "POURQUOI-PAS."

THE FRENCH ANTARCTIC EXPEDITION.

BY DR. JEAN CHARCOT.

On leaving Deception Island (latitude 62 degrees minutes south) we made our way to Port Lockroy where we commenced our work. From here I made a trip of observation with Godefroy and Gourdon to Wandel in order to study the lay of the ice which would save both the coal and time. This little journey of forty miles was exciting enough and the final result of it was satisfactory. Some days later we arrived with the Pourquoi-pas at Wandel we had bad weather on the way with a strong northeast wind. The creek was rather small for our vessel we had not had the time to install a satisfactory barrier and the small ice did not protect us. For a week we were in danger there unable to come out assailed by enormous ice blocks which had to be fended off or pushed up night and day. The photographs clearly describe our condition.

On January 1st Godefroy Jacques Gourdon and I made a reconnaissance to find a better shelter when we found at Petermann Island the harbor which we named in honor of the day Circumcision. A few days after we brought the Pourquoi-pas round having escaped from Wandel without suffering any serious damage by gently wriggling round the icebergs. I set out the same day with Godefroy and Gourdon to explore the south chiefly to climb some eminence to see whether we had any channels to pass with the Pourquoi-pas between Bisco Island and the coast. As we reckoned upon returning the same day we had taken neither supplies nor change of clothes. Our mission was easily fulfilled and we saw that the coast was blocked but when we wanted to retrace our steps we found that our path was quite blocked by the ice. During a four days blinding snow storm we struggled to liberate ourselves. I will pass over the details of that trial. We were in peril of succumbing from hunger and cold on the fourth day we shouldered our traps and determined to attempt some vulnerable part of the ice cliffs where our signals might be observed by our comrades when the Pourquoi-pas came to our rescue skillfully guided by Bongrain and Rouch whose performances on the siren could be heard through the fog and snow.

On the journey back unfortunately the vessel stranded violently upon one of the innumerable reefs level with the water and we had to unload. After three days and three nights incessant labor we got her off again. But we had to leave behind a large piece of her prow and it was with the vessel in this state that we accomplished the whole of our expedition.

From Petermann Island we went toward the south skirting the coast and completing the chart of the Français. We found the bay which was marked by Pendleton the American whaler and discovered to the north of Adelaide Island a large bay which we have since named Matha Bay. We next took hydrographic observations of Adelaide Island which has a very peculiar configuration. But instead of being eight miles in length as is generally supposed the configuration has a length of seventy miles. South of Adelaide in a region neither explored nor ever seen we discovered a great bay which I have named Marguerite. We entered here despite the reefs and compact ice and anchored at a little isle which I named Jenny after Bongrain's wife. We now encountered such violent weather for four days that it was a miracle the vessel escaped. An enormous iceberg appeared in front of us from which only a series of tacks saved us. During our sojourn at that little island three of my men made a two days excursion which enabled them to explore the seas between Adelaide and Terre Loubet. To the south of Marguerite Bay we were continually fighting our way through ice and icebergs but we managed to take soundings of the sea bottom round 120 miles of unknown coast. After two attempts to find our way across the ice to Alexander Land we decided to abandon the project till the following summer.

Despite our efforts to do so we were unable to winter here. Even if we had decided to do so it would have been disastrous to our observations and the drift ice would have carried us far from the land. It is impossible to convey any impression of the icebergs and the drift ice in this region. We were obliged to return to Petermann Island where we were able with our superior equipment to confirm and amplify the observation made by the Français and other expeditions. This summer campaign despite some bad weather provided us with sufficient atmospheric clarity to take numerous photographs and make observations. The battle with the ice was severe and continuous but the vessel behaved admirably.

Our winter station was organized as comfortably as possible. Numerous observations were taken with the electric light and during a three days tour I found that the movable house of the Français made a more comfortable observatory. During the autumn we made numerous excursions. We saw no sun for five days the wind blew strongly from the northeast and the snow fell heavily. The ice floes were continually shifting. Many icebergs passed. Despite all precautions our barrier was frequently broken. The ship was often in danger and her rudder was smashed we constructed a new one by cutting up a spar.

This painful winter had a serious effect upon the health of the party. Several suffered from scurvy and one from myocarditis. It was only seals flesh which kept us alive.

An expedition to cross Graham's Land was prepared with great care. I intended to lead it myself but I was disabled by scurvy. Gourdon took my place setting out with six companions. They brought back some interesting observations but without being able to scale the insurmountable barrier of granite and ice. Other excursions were also made. After considerable trouble toward the end of November we were able to get the ship free. We returned to Deception Island where we found some whalers who had been held up by ice and bad weather. Here we were heartily welcomed by M. Anderson and his wife on the Chilean steamer Gobernador Bories. With great generosity they helped us by all means at their disposal and supplied us with one hundred tons of coal by order of the Magellan Whalers Society. As our vessel was making two tons of water an hour the diver who had attempted to float the steamer 'Telefon stranded the year before examined our keel. He could do no more than confirm the gravity of the damage to the bow and some minor damages. We rapidly installed our scientific apparatus on shore. Our naturalist and geologist were able to perform some good work. From Deception Island I wanted to make for Joinville Land to seek for fossils but the ice very quickly compelled me to change my plan. We did not wish to endanger our journey southward or to suffer the fate which befell the Antarctic in the same latitude. After a brief struggle we were beaten back to Bridgeman Island where we landed then to Admiralty Bay and the south coast of the Shetlands where we did some good work.

Thence we set out to the south, the weather all along being bad and misty and the ice and icebergs abundant. Nevertheless we were able to go beyond all the latitudes attained to the southwest of Alexander Land and to complete the chart.

We then discovered a series of new lands to the south and west of Alexander Land in an unexpected place thus solving an important problem. The deplorable ice belt barred our nearer approach in one hour we got no farther than ten *yards!* We continued our route by following the ice barrier until we reached Peter I Island which has not been seen since Bellingshausen discovered it. There we were overwhelmed by a tempest and thick mist during which we had to steer carefully among the icebergs. They were so numerous that I estimated we saw more than 000 of them in less than a week. We had to drift without steam all the time through a fog so dense that we could not see farther than twenty yards ahead. Despite this and the strong gusts of wind we reached the 124th degree longitude west having sailed from the place where the Belgica set out between 69 degrees and 71 degrees latitude that is to say well to the south of both Cook and Bellingshausen. Our stock of coal being exhausted the health of several of the party became alarming. We had to turn our faces northward for a long time the icebergs had been innumerable but they gradually diminished and finally we saw the last. The crossing of the Antarctic to Cape Pillar was extremely rapid thanks to an uninterrupted series of southwesterly and north northwesterly winds but the sea was terrific. In ten days we arrived at the entrance of the Magellan Straits where we encountered severe weather.

We experienced several anxious hours round the coast but the magnificent qualities of the vessel and her fine machinery aided by sails enabled us to make good use of the wind and to anchor for some hours in Tuesday Bay. The men's health and the necessity for condensing water for the boilers determined me to spend four days in the straits. Owing to the unfavorable situation in Tuesday Bay we moved on to Puerto Gallante where we were able to procure fresh meat and vegetables. We anchored at Punta Arenas where we were heartily received after fourteen months absence. During the second summer campaign as well as the first numerous soundings and draggings had been carried out. Whether among the ice or upon the open sea the vessel behaved excellently and we had not a single breakdown of the machines. The ship must have been remarkably solid to stand it all. Her equipment was perfect. As for the staff the scientific results of the mission are due to their noble and incessant labor while the scientific programme was scrupulously carried out. London Standard.

With the ordinary method for examining a transparent body under stress by means of polarized light the body is placed between crossed Nicol prisms. Under these conditions the optical effect observed depends on the particular angle at which the specimen, or any part of it is placed and if the stresses are radial in direction as with a short cylinder or circular disk of glass which has been suddenly cooled a black cross is observed with its pairs of arms respectively parallel to the planes of polarization of polarizer and analyzer the light being a maximum for directions making 45 deg. with these arms. In a paper read before the British Association for the Advancement of Science at its Winnipeg meeting, S. P. Thompson and E. G. Coker show that these disadvantages are avoided by substituting circularly polarizing apparatus for both analyzer and polarizer. For this purpose use is made of two thin plates of mica (or of quartz cut parallel to the axis of crystallization) which gives as nearly as possible a retardation of one quarter wave length for yellow light between their ordinary and extraordinary rays. Ordinary quarter-wave plates differ considerably among themselves and it is important that the pair chosen should be alike in optical property. One must be large enough to cover the whole field of view this being placed between the polarizer and the object preferably attached to the polarizer—and set with its axis at 45 deg. to the plane of polarization of the polarizer. The smaller quarter wave plate is placed between object and analyzer—best attached to the latter—so as to rotate with it its axis being exactly at 45 deg. to the plane of polarization of the analyzer. If this plate receives a beam of circularly polarized light it transmutes that beam into plane polarized light which is either cut off or transmitted by the analyzer according to whether its own axis is at 45 deg. to the left or to the right, that is according as the cheirality of the analyzing combination of quarter wave plate and nicol is opposed to or concordant with the cheirality of the polarizing combination. With this arrangement the black cross entirely disappears and with the exception of certain slight changes of tint the optical appearance of any polarizing object placed in the apparatus remains invariable at whatever angle that object is placed in the field. As a material more compressible than glass and hence not so readily fractured Thompson and Coker employ a particular kind of xylonite, sheets 3—4 millimeters in thickness being practically transparent even 10 millimeters thickness may be used.

. consideration of the mechanical principles involved in valve construction and the duty required lead to the conclusion says a contemporary that electrically operated stop valves offer many advantages as compared with the hand-operated type. They can be operated from any point often permit a simpler laying out of piping and, in time of accident, make it possible to shut off a valve that might otherwise be inaccessible on account of fire escape of steam, etc. The stopping and starting of large units upon short notice is expedited by motor driven valves for the large exhaust piping, and when installed between the boilers and steam header or the header and the engine, and between sections of the header, they enable any break in the piping to be isolated at once or any other trouble checked by closing switches which may be situated a safe distance away from the piping.

THE MECHANISM OF PROGRESS.

A THEORY OF INVENTIVENESS.

BY PROF. R. S. WOODWORTH.

PROGRESS depends first of all on human inventiveness—so much will probably be allowed. Under the head of inventions should be included not only mechanical devices, but works of art and government, business enterprises and changes in custom, so far as any of these demand originality in their producers. Science and all increase in knowledge should also be included, since the process of discovery differs but little from the process of invention. In both the essential mental act seems to be a bringing together of things that are found apart, or a pulling apart of what occurs together. In fact, both of these processes, the combining or associating and the analytic or discriminating, go on together, since we see something new in a thing when we are reminded by it of something else and different. There is a suggestion of the accidental in all invention, since it depends on happening to notice something or happening to be reminded of something. You can not be sure that a person will make a discovery, even when you supply him with the elements which would combine to produce it. Oftentimes in reading the history of scientific progress one is surprised that a certain discovery was not made by some man who had apparently everything before him to lead to it. Invention is of the nature of a spontaneous variation, and this accidental character is very important in understanding the mechanism of progress.

On the other hand, since one cannot be reminded of things entirely unknown, invention depends on previously acquired knowledge, and the inventiveness of an individual must take a direction prepared for him by the social group among which he lives. A large share of the inventiveness of the Australian natives seems to be directed into the channels of magic and ceremony. The finished product of one mind's inventiveness becomes raw material for another, and invention of all sorts is distinctly a co-operative enterprise.

Invention is said to be mothered by necessity, and the proverb is no doubt true in the main, though curiosity and experimentation belong among the play instincts. But in any case the necessity must not be too dire, for some degree of leisure is demanded if anything novel is to be thought of, and rapid progress is only possible when individuals can be allowed to accumulate the special knowledge which may serve as the raw material for their inventive activity. Divisions of labor, guilds, universities, legislatures, investigating commissions, permanent research bureaus, each of which is genetically a series of inventions, are dependent for their existence on a certain degree of leisure, while they in turn provide more leisure and opportunity for further advance. They are inventions which accelerate the progress of invention. There are thus many factors besides the intellectual endowment of a generation which go to determine the progress which it shall make. The spur of necessity, the opportunity afforded by leisure, the existing stock of knowledge and inventions, and the factor of apparent accident or luck, have all to be considered.

A still further factor is the size of the group, which is deserving of renewed attention. Not only does a large group afford more opportunity for division of labor and special institutions for research, but the biological consideration already mentioned should be emphasized. The contributions to progress of the average man are small, the inventions of moment arising in the brains of a small fraction of the group. A large group provides a greater number of inventive minds, and it is rather the absolute number of such than their proportion to the whole population that determines the progress of invention within a group. The group needs to be redefined from the point of view of invention. If knowledge and inventions pass back and forth between two nations or races, the inventive minds of both are brought into co-operation, and the group is by so much enlarged. From the point of view of progress, however, the question is not simply how many inventive minds are brought into co-operation, but how free and rapid the communication is between them. At the present time a discovery originating anywhere in Europe or its colonies is quickly known by specialists in all parts, and may promptly fructify the mind of a distant investigator, leading to a fresh advance. The invention of printing and of rapid means of communication must be credited with a large share of the rapid progress which has been made by the last few generations. Much also must be credited to the invention of steam power, which has vastly multiplied the size of the European group in an economic sense, and set free many minds of ability for productive thinking. The very idea of the advancement of science and invention as an end to be striven for is to be classed as an invention, and a rather recent one, and it, too, is an accelerator.

Such considerations provide at least a partial explanation of the different rates of progress in different generations and among different races. Whether they explain everything could perhaps only be determined by a drastic experiment, which it will do no harm to imagine, though the question will never be settled in this convincing way.

Let two or more habitats, isolated from each other and from the rest of the world, and as nearly as possible alike, be chosen and peopled by two equal groups of children selected from some highly civilized nation, and so selected as to represent fairly the distribution of mental and physical traits among that nation. For every individual in the first group let there be a practically identical individual in the second. Let these groups of children be introduced into their new homes in infancy, and by some quasi-miraculous means let them be all preserved to maturity, and then let them and their descendants be left entirely to their own devices, without fire or a language or other modern improvements. To watch such a spectacle from afar would be thrilling, if not too pitiful. We can readily grant that the infant communities would begin at the very zero of civilization, and that their progress for many generations would seem excessively slow. But the real point of the experiment is to inquire whether the two equal groups, alike in number, in heredity and in environment, would remain alike and progress at equal rates. Probably they would not. We must allow for chance in the mating of males and females within each group, and consequently for changes and inequalities in the distribution and correlation of traits, changes which need not alter the average of either group.

We must also allow for spontaneous variation in the offspring, another accidental factor, by virtue of which unusually inventive and effective individuals or conjunction of such would almost certainly arise in one group rather than in the other, and give the advance of one group an impetus which might be felt through many generations and carry this group far ahead of the other. And we must allow also for the accidental factor in invention. Even though the genius of one group was paired by an equal genius in the other, it is improbable that both would invent the same things. One might invent a hunting implement and the other a fishing implement, and by this accident the direction of development might be settled for each group. If we followed the experiment after a thousand generations, we should probably find two peoples of different language, different customs, and cultures divergent in many respects. The supposed result may be taken as an assertion of the importance of accident in determining the destiny of peoples. Obscure causes are no doubt at work beneath the accidents, but we cannot trace them, nor reasonably state them in terms of racial superiority and inferiority.

It would seem that size of groups and accidental factors exert so much influence on the rate of advance in civilization that differences of culture could possibly be explained without supposing the mental endowments of the races to differ. Whether the existing races of men do or do not differ in such a trait as inventiveness is another and more difficult problem, the settlement of which must be left to time and educational experiments. The experiments must be continued for several generations in order to equate social traditions. Regarding the negroes of the south, I am informed by a gentleman who has spent twenty years in educating them that a distinct advance is perceptible during this period, especially among the children of educated parents. These have more educational ambition, enter school earlier, and have less to unlearn. The educational experiment, as far as it has gone, thus shows that much time will be needed before a clear result is reached.—Abstracted from a paper read before the American Association for the Advancement of Science.

AN ELECTRO-MAGNETIC SOUNDING APPARATUS

By the Berlin Correspondent of the SCIENTIFIC AMERICAN.

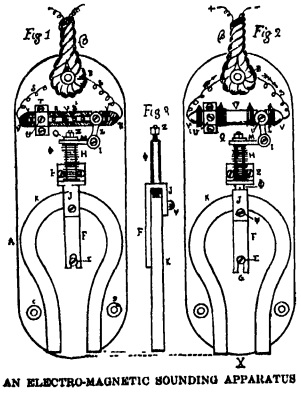
AFTER the loss of the submarine "Lutin" in 1906, Mr. Augustin Coret of Neuilly, near Paris, conceived the plan of an electro-magnetic sounding device to locate a lost automobile torpedo.

The inventor has now improved his original scheme by replacing the electro-magnet by a permanent horseshoe magnet.

The electro-magnetic sounding device consists of two copper plates *AA*, united by ivory pegs *BCD*. To one of these pegs is fixed by means of two screws a square *E*, into the hole of which penetrates the round portion of the guide of a magnet *K*. The plane portion *F* of the latter carries an angle δ, in which the magnet is fixed by a screw ϕ, while its end is attached to the plate *A* by a screw Σ passing through a slot *G*.

The upper end of the guide is connected with the arm *M* of a lever *l*, through which it passes. A nut *Z* and a ring *O* cause this lever to take part in any motion of the guide. The other arm *L* carries a round head *P*, in which is fixed by a screw *U* an ivory or ebony rod *OO*. To this ivory rod is screwed one of the contacts *R* of the wire *S*, supplying current through a cable fixed to the apparatus from a battery installed on board a ship or boat.

The support *T*, fixed by two screws to the plate *A*, carries, by means of another screw *U*, another ivory rod *OO*, into which is screwed the other electrical contact *R*. The conducting wire *S*, connected to *R*, communicates with the cable and the other terminal of the battery. The ivory rods are covered with caoutchouc sleeves *VVV*, to insulate them against sea water. These sleeves are kept on the rods by windings of copper wires. A spiral spring *H*, surrounding the round portion of the magnet guide and pressing against the square *E* and the arm *M* of the lever *l*, prevents the electric contacts from touching one another as long as the sounding apparatus is kept away from any iron or steel masses.



AN ELECTRO-MAGNETIC SOUNDING APPARATUS

In order to locate a submarine or torpedo at the bottom of the sea, the sounding device should be taken to the spot. As soon as its magnet approaches a piece of the iron or steel of the hull, it will be attracted, and owing to the effects of the spiral spring, the two contacts will touch each other, so that the electric current, by actuating a bell installed on board a ship or boat, indicates that the submarine or torpedo is really at that point. In case of a negative result, a sounding should be made at another spot, and the diver should not start his work before the bell has signaled the presence of the submarine or torpedo.

Should the sounding device come into contact with the bottom of the sea or else with a stone or other solid object (not of iron or steel), the impact will cause the contacts to touch each other, thus actuating the bell, but only during one or two seconds, as the force of the spring immediately separates the contacts. Whenever the magnet is attracted by iron or steel, the bell is rung uninterruptedly.

MODERN STEREOTYPY.*

THE MECHANICS OF THE NEWSPAPER.

BY HENRY A. WISE WOOD.

PRINTING began with the making of hand cut blocks which were used to stamp their similitude upon other surfaces Later blocks called type bearing each a single character were made and these when combined one with another produced words which when gathered into sentences and paragraphs became the page The great impetus given the typographic art by the introduction of movable types was due to the ease and economy with which text could be prepared for the press and after printing the type page resolved again into its component characters which thereupon were fit and ready for further use

The work of cutting characters being slow and costly recourse was soon had to casting them of an alloy of lead antimony and tin from molds now called matrices These were made of plaster from types or dies which had been cut by hand and later of copper from harder dies which upon being driven into it left their impress Until recently the driven matrix was exclusively used but nowadays the manufacturers of type cut their matrices by means of a power driven engraving device the controlling lever of which is guided by hand along the edges of a large template or raised representation of the particular character to be cut Thus by means of the Benton Waldo machine unskilled men working with great rapidity can produce the most intricate matrices at little cost When matrices are required to be made in large quantities as for use with the type making and composing machines of the modern printing office they are still driven the dies or punches employed being engraved by the Benton Waldo method The matrices of extremely large type sizes which are now upon the market are usually neither punched nor cut but are electrolytically deposited copper impressions of existing types

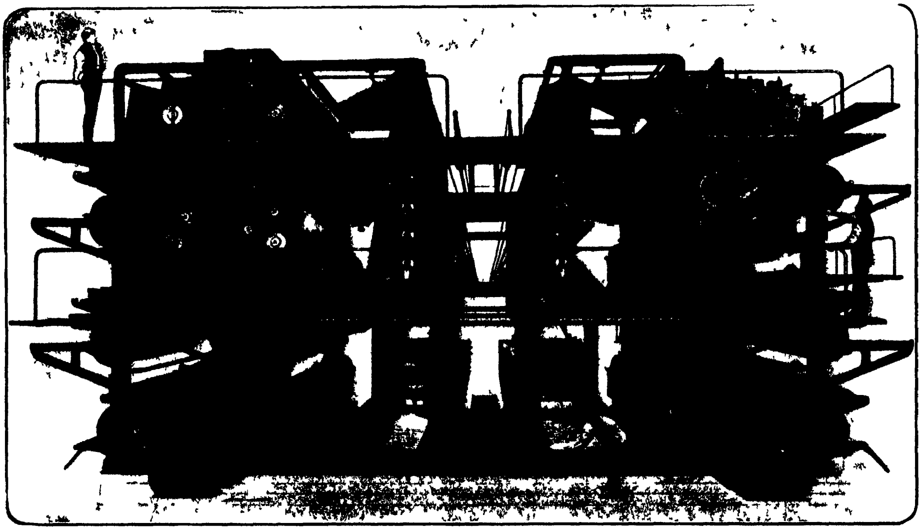
For many centuries the setting of type was a manual operation It required a high degree of special knowledge and great dexterity With the setting or "composition" of a page the typesetter's work did not end when the page was no longer required he had also to "distribute" the type it contained The putting of matter into type involved the necessity of taking it out again Such a dual process was entirely comfortable to the printer until and long after the newspaper came into being But when the value of celerity in the printing of news began to be understood the slowness of the man at the case became irksome and a mechanical substitute for his eyes and hands was sought This brought into being the crude type setting devices of the third quarter of the last century These like the man had to distribute as well as to compose and each function was given a mechanism of its own

Meanwhile the growth of the newspaper in telegraphic matter and general bulk was pushing it on to demand still more rapid and ample appliances and these so far as the composing room was concerned were at last supplied by Mergenthaler's matrix setting and type line casting machine called the Linotype (line of type) This device worked upon a new principle Instead of seeking to set the types and after their use to distribute them among their respective receptacles in order that they might again be automatically composed it composed the matrices of type, and from these cast as a single piece a line of characters Mergenthaler's matrix was of brass flat and rectangular having a V shaped notch cut deep into one its upper end the edges of which were lined with small hook like protrusions These protrusions were arranged to act like the convolutions of a flat lock key because of them a matrix could drop from the V shaped ward bar from which it hung during its automatic distribution after use only into its own reservoir or channel of the matrix magazine The magazine and matrix distributing apparatus occupied the upper portion of Mergenthaler's machine and to it after each had been once used the matrices were automatically returned The convolutions of the matrices of each character were alike, but those of no two characters were the same

From the channel like reservoirs of the magazine the matrices were released in the order in which they were wanted by the manipulation of finger keys, and upon coming from the magazine were assembled side by side with their intaglio characters in line A wedge like piece was inserted between each pair of words to wedge the line out to its full width should it be short, a function spoken of in typography as justifying The assembled matrices and wedges were thereupon automatically transported to a casting mechanism where their character casting surfaces were pressed against the mouth of a slot or mold which was as long as the width of the column of the newspaper for which the line was to be cast and of breadth suitable to the size of the type face required In depth the mold was type-high Against the opposite opening of the mold was placed the nozzle of a pump by which at the proper moment the mold was filled with type metal and a bar cast having upon one edge the line of type The mold was then automatically moved clear of matrices and of pump and the bottom of the cast smoothed by a knife Then the cast or slug having been ejected between knives to give it accurate thickness was ready for use Meanwhile the matrices were lifted to a position abreast the top of the line of reservoirs from which they had come whence suspended each by its particular convolutions from the wards of the V shaped bar along which they slid they were pushed over the mouths of the channels and each character dropped where its retaining ward ended The wedges or space bands were left behind when the matrices were elevated and returned to their starting point

Thus by the mere acts of playing his keys and touching a handle upon the assemblage of a line of matrices an operator was enabled to make composed and justified lines of new type at a then unheard of rate of speed Moreover, the "type" he had set needed not to be distributed for re-use the line had only to be tossed into the melting pot of the machine to be born again as new matter Where other mechanical compositors had required three men for their use, one to set another to justify, and a third to distribute their work the Linotype needed but one and could be worked with such ease and rapidity that it went instantly into general use

Upon the heels of the success of the Linotype came another device, the Monotype which although not of so great value to the newspaper publisher was gladly received by the printer of books and commercial work The Monotype consisted of two independent mechanisms, the one a keyboard by means of which the operator was enabled rapidly to perforate a paper ribbon



THE LARGEST PRESS IN THE WORLD—THE DOUBLE SEXTUPLE PRESS FOR NEWSPAPER WORK

Two complete printing mechanisms each fed from three rolls of paper [illegible] twelve plate carrying [illegible] each carrying eight plates Press is [illegible] feet long [illegible] feet high and weighs [illegible] 000 pounds Fifty thousand parts It will print 150 000 eight page papers per hour and deliver them folded and counted

MODERN STEREOTYPY

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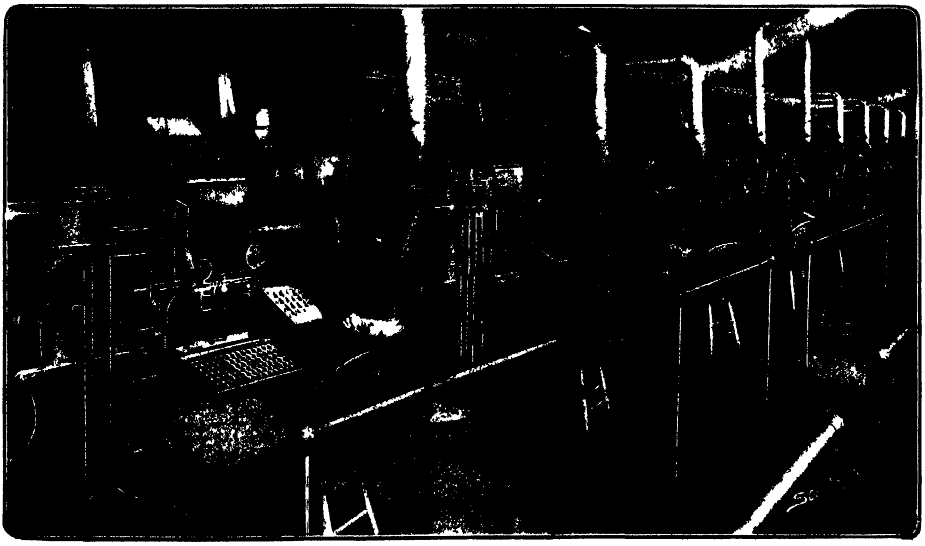
* Read before the Franklin Institute.

with holes which represent characters, and the other a type-casting mechanism to which the perforated tape thereafter was fed. The latter device comprised a movable frame in which the matrices of 225 characters were fastened, a type mold automatically adjustable to suit the various widths of the characters of the alphabet, with which a metal pump was connected, and pneumatic mechanisms for controlling the position of the matrix carrying frame and the width of the type mold. To these was added a general mechanical organization which enabled the perforations of the ribbon by means of air as it was drawn through the machine to properly place the matrix frame and set the mold for each character needed, while the pump and co-operating parts acted to cast the character and place it in its correct position in a tray or "galley," at the rate of 150 characters a minute.

Of all the type setting machines properly so called which preceded the Linotype but one has survived, the Thorn Simplex Unitype machine. In this foundry type are contained in slot like reservoirs cut in the periphery of a drum. About the bottom of this drum, which stands on end, rotates a flat disk, and out upon this the type are thrust when released by the keys, and by it are carried in the order of their release into a mechanism which picks them up, puts them on their feet and assembles them into a line. They are then taken in lengths of a column's width and after being quickly justified by hand are ready for use. A clever device of this machine is the means by which it is enabled to take a whole galley of type and properly distribute it among its reservoirs. This is accomplished by providing the type-body of each character with an arrangement of "nicks" which is possessed by the body of no other characters. At the head of each slot like reservoir is a particular arrangement of wards like those of a lock. The wards of a reservoir will permit to enter it only the character whose body has nicks to suit. The lines of type which are to be distributed are automatically taken from their galley and inserted, a line at a time, into slots in another drum. This surmounts the reservoir drum already referred to, their axes and the alignment of their slots being common to both. The upper drum rotates with a step-by step motion and at every stoppage its slots coincide with those of the lower drum. Thus it will be seen that as soon as a character carried by the distributing drum reaches a position above its own reservoir, it will drop into it but that no other character can do so. The Unitype machine being less costly to purchase and more economical to run than Linotype or Monotype, is in very wide use among the smaller newspapers and printers of books and magazines.



BATTERY OF FIFTY SEVEN LINOTYPE MACHINES

Average product 4,000 letters the width of the letter [illegible] per hour. Each machine spaces or justifies the line and delivers a cast slug.

MODERN STEREOTYPY

In these few words I have sought hastily to carry the art of type setting through its various stages of progress, and to describe the mechanisms by which it is practised to-day. Where an expert compositor formerly could set by hand but 750 "ems"* an hour he has been known with a modern machine to set from 3,000 to 12,000 ems. Such large daily papers as the New York Herald and the New York World use from 60 to 70 Linotype machines each (the New York Sun uses Monotypes). Without such a machine it would be physically impossible to issue newspapers of this class in so far as their bulk and the celerity of their publication is concerned. So much has the mechanician done for the setting of type.

Coincident with the introduction of movable types one first hears of the printing press. This instrument is said to have come of humble origin, to have been in fact but a development of the cheese or cider press common in mediæval times. It first consisted of two plates between which the inked type covered with a sheet of paper was introduced and by which it was pressed. The necessary squeeze was applied by means of a hand turned screw set in a surrounding frame which bore upon the upper plate. Next came an improved form of screw-operating mechanism. Next the lower plate was made to slide out to receive the type "form," as it is now called. And later a frame covered with fabric to which the sheet was secured was made to hinge down upon the type before the table upon which the type rested should be slid beneath the upper plate. This table is now called the "bed," and the sheet pressing plate the "platen" of a press. In those days the ink was applied by means of hair stuffed leathern balls. These, dabbed with ink, were patted together until their ink film was suitably evened out or distributed, and were then carefully pressed upon the type. With such a press about 200 sheets of small size printed upon but one side could be done in an hour. At its next step the press became of iron and was adapted to print larger sheets. Then a genius conceived the idea of replacing the flat sheet pressing platen by a rotating cylinder upon the surface of which the sheet was held by bands of tape. Beneath this cylinder the type form was pushed, and thus the cylinder printing press was born. Next were applied ink charged rollers made of glue and molasses which, as the type was pushed toward the cylinder, served to ink it. Better means for propelling the type bearing table or bed were soon forthcoming, as well as for causing the cylinder to turn more accurately and with greater certainty to take on and give off the sheet. Power other than that of the hand was applied, and it became possible to print upon one side of a sheet at the rate of a thousand impressions an hour.

Meanwhile the flat or "platen press," as it is called, shared in the general advancement of the engineering arts. It became a self acting machine of itself, took its sheet from the hand of the printer and drew it into position to be printed and impressed it upon the type which it had previously inked. Then after it gently laid the sheet upon a table, a thousand such sheets to the hour. Having attained to this degree of development the growth of the platen species of printing press ceased forthwith, and except in connection with the smaller sizes of commercial work and a few obscure branches of the printing industry it is no longer a factor.

As an increasing speed of production is ever of the essence of industrial progress, the mechanical species which survive are necessarily those which lend themselves to celerity. Of such a species was the cylinder printing press. With the betterment of materials and of motion producing mechanisms the attainable speed of its reciprocating type bed and its sheet bearing cylinder soon enabled it to outrun the older and more cumbrous flat press, and thus it came to assume the burdens of news printing. The single cylinder press printing upon one side of a sheet was soon followed by a machine having two sheet bearing cylinders and a double length bed upon which forms of type for printing the back as well as the front of a sheet were borne. By an ingenious arrangement of endless tapes the sheet having been printed upon one side by one cylinder was transferred to another cylinder and by it printed upon its other side. Such a press was said to "perfect" the sheet and so came to assume the name of "sheet perfecter." Other double cylindered presses also were used which were adapted to print upon but one side of the sheet. Such a machine carried upon its bed a single form of type to which each cylinder in turn presented a sheet, the one cylinder upon the forward stroke and the other upon the backward stroke of the bed.

Fifteen hundred papers an hour were not, however, long going to satisfy a public rapidly growing in its appetite for news, so another step was taken, this time by Applegath for the London Times. By setting a cylinder upon its end, its axis in vertical position, and fastening into it the metal column rules of the paper, Applegath was enabled to lay the columns of type between these rules and so clamp them to the column wide facets of his cylinder as to cause the type to withstand the centrifugal force of a quite respectable velocity of rotation. About this type bearing cylinder were set parallel sheet bearing cylinders, to and from which hand fed sheets were conveyed by rather complicated systems of tapes. In this way the Times for many years was printed. Not in this coun try conceived a better arrangement By the use of wedge shaped column rules he was enabled so firmly to hold the columns of type in place as to enable him to set his cylinders in a horizontal position Hoe presses having four six eight and even ten sheet bearing cylinders which ran in contact with a central type bearing cylinder came into general use Having a speed of two thousand turns of the type cylinder an hour such a press with ten sheet bearing cylinders was capable of turning off twenty thousand sheets These being printed upon but one side had of course to be put through the press again the type pages meanwhile having been changed Hoe's next step was to place in a machine two type bearing cylinders so that both sides of a news sheet might be printed at a single operation

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* The "em" represents the square of the size of the type used, and is derived from the letter M, which is as broad as it is long. It is the unit by which composition is measured. If a column is 18 "ems" wide and [illegible] lines long, it is said to contain 600 "ems."

But even ten or twenty thousand newspapers an hour failed to satisfy the growing public need The presses of the day were already working at top speed Type setting was so slow and costly that forms could not be set for more than one press so an establishment was limited to the use of a single machine Something had to be done For some time there had been known and used the process of stereotyping which was that of producing replicas of a form of type in type metal To practise stereotyping a type form was stamped into a moist clay surface where it left its impression The clay was baked then put into a receptacle and type metal poured upon it When the cast had cooled the clay was broken from its surface its edges were trimmed with a tool and its back smoothed with a plane Then it was ready for press By repeating the process of molding and casting it was possible to continue indefinitely to reproduce a type form But the resulting stereotypes were flat and for the rotary news press it was desirable if higher speed were to be obtained that printing forms should conform to the curve of its cylinder

In this hour of the newspapers need someone it is not certain who conceived the idea of substituting for the clay for stereotyping a sheet of papier maché This was composed of several thicknesses of soft paper moistened with paste and covered with a skin of tissue It was laid upon the type and beaten in with a brush Type and paper were then covered with a dry blanket of felt and thrust into an oven like press till the matrix was dry Such a matrix being flexible could be conformed to the interior of a curved casting receptacle and being tough could be stripped from a cast and used again This method of stereotyping originated abroad and was brought to this country by Traske who first put it to work upon the New York Herald and the New York Sun Thus for the first time the newspaper was enabled to make innumerable curved replicas of its type forms and indefinitely to multiply the number of its printing machines It should be noted in passing that with the advent of the curved stereotyped printing plate the larger newspapers ceased for good to use type for the purpose of printing

The substitution of curved stereotyped printing plates for type gave to the newspaper two new advantages Many presses could be used and these could be run at higher speeds than were possible where printing surfaces were made up of individual types which were held to a cylinder merely by wedges Bullock of Pittsburg was the first to offer a press which properly utilized these advantages His machine was not only adapted to use curved stereotypes at a high rate of speed but to it he had attached a device for severing sheets from a roll of paper thereby feeding his press automatically and another device for rapidly laying the sheets when printed neatly in piles His press thus being automatically fed and delivered and adapted to print from curved plates upon both sides of a sheet quickly came into general use Hand fed machines for folding newspapers were already in vogue so it was but a short step to the attachment of such a folding machine to the press itself

But progress was still insistently at work The annoyance of carrying separate sheets through a rapidly running machine must be dispensed with This was soon accomplished and the paper was drawn from the roll into the press and printed while still in web form upon both its sides Then it was cut into sheets and folded Thus there resulted the web printing as distinct from the sheet printing machine

Further improvements now follow one another in rapid succession The slow intricate and uncertain chopping blade folder at first employed was replaced by a rotary device which working with simplicity and accuracy at a much higher velocity greatly increased the productivity of the press The products of two presses were next run into a single folder which thereupon delivered a folded newspaper of double the usual number of pages These two innovations were first put into practice by Andrew Campbell* of New York city The columns of the print which theretofore had run across the web were next turned about and run with it Thus the center margin of the newspaper along which it is folded became the center line of the web As a curved stereotyped plate occupies but half the circumference of the cylinder of a newspaper press two were required to complete the circle As each printing cylinder bore four such plates and there were two such cylinders it was possible at each revolution to print an eight paged paper By cutting the sheet from the web between the forward and after pages and laying the first half upon the last an easily handled eight paged paper became possible Such a paper had neither to be cut by hand nor turned inside out in order that its pages might be read by the holder in sequence This operation was called collecting There were occasions when the forward and following plates were alike then the sheet collecting mechanism was disconnected and the papers delivered had but half the number of pages In this way four paged papers were run Such a press was able to deliver twice as many papers having four pages as eight The products of two printing machines when run together into a collecting mechanism and folder resulted in sixteen paged newspapers But with the collector thrown out of operation twice as many eight paged papers could be obtained With three presses the respective products were twenty four paged if collected twelve if uncollected with four presses thirty two and sixteen Meanwhile it had become possible to combine the full width web of one press with a half width web one page in width brought from another Thus such a product if not collected produced a six paged paper or if collected a paper of twelve pages In this manner it became possible to print at will upon a machine having four printing couples newspapers with four six eight ten twelve fourteen sixteen twenty twenty four twenty eight or thirty two pages

Meanwhile the practice of cutting sheets from the web before they were folded had given way to a more certain and rapid method A new form of folding device was introduced which comprised a V shaped frame of iron down over which the printed web was drawn by two milled rolls running toward each other at its lowermost point The web coming full width over this device was so shaped or formed in the course of its travel downwardly over its face and about its sides as to enter the rolls beneath its "nose" as a folded web Thus it became possible to give the sheet while on the run its first its longitudinal fold and to do this before it should be severed from the web Beneath this device or 'former,' as it is called was placed a pair of cylinders which cooperated to give the already once folded sheet its second or transverse fold and thereafter to sever it from the web The act of cutting was accomplished by pressing a sharp serrated blade carried by one cylinder into a slotted rubber bar carried by the other The principle of cutting demanded that the sheet be held taut over the cutting slot while the saw toothed blade burst through it This was accomplished by placing at each side of the knife spring supported wooden bars which pressing the paper against the rubber at each side of the blade held it taut at the moment of cutting One of the cutting cylinders bore pins which by impaling the leading end of the once folded web enabled it to carry the paper part way around until the instant arrived at which it was cut from the web and became a sheet ' Then as the pins released its forward end it was struck across its middle by a suddenly protruded folding blade carried within the cylinder and driven downwardly between a pair of cooperating rollers by which a second or transverse fold was given it The twice folded paper was then shot into a rotating frame of S shaped arms called a fly which laid it upon a slowly moving apron of endless bands from which when papers enough had gathered it was removed by hand Working in conjunction with the fly was a device which slightly threw out of position every fiftieth paper so the necessity of hand counting except for smaller quantities was dispensed with It should be added that the cylinder which was opposed to the sheet bearing cylinder described was so fitted with pins that it could also perform the function of collecting and thus papers of double the number of pages be produced This cylinder bore the serrated knife, while the sheet bearing cylinder carried the rubber slot and folding blade described When it was wished to collect the forward with the after product of the press the pin mechanism carried by the knife cylinder picked from the other cylinder the first coming sheet by its forward edge and after making a revolution which gave the second sheet time to arrive replaced the first sheet upon the first cylinder directly upon the second sheet The collected product was thereafter folded delivered and counted as a single newspaper

But two other features of the press under description—which is the newspress of the present day—remain to be mentioned Some years ago it became the practice to construct presses four pages in width This necessitated the employment of double width webs Its advantage lay in the fact that by means of two rounded bars set at an angle of 45 degrees with respect to the direction of travel of the paper it was possible after the web was printed and split to transfer part of it across the press and impose it upon its other part Thus the portion of the web printed at one side of a press could be transferred laterally and associated with the portion printed at the other side of the machine and both pass into a folder to emerge as a single product of a greater number of pages

(To be continued)

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* Machines embodying Campbell's rotary folder were used by the [illegible] city [illegible] Cleveland Leader In the last named [illegible] machine [illegible] two presses were run into one folding mechanism and there [illegible] a single product Campbell failed to patent his inventions and thus lost them

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WIND STATISTICS FOR AERONAUTS.

The appearance of a comprehensive analysis of the winds of Germany (Die Winde in Deutschland Braunschweig 1910) prepared specially for the information of aeronauts by Dr Richard Assmann is significant of the fact that in Germany at least meteorology and aeronautics are advancing hand in hand The author is director of the great aerological observatory at Lindenberg and chairman of the scientific committee of a society of aeronauts at Berlin the Motorluftschiff Studiengesellschaft under whose auspices and at whose expense the work has been published

By means of tables text and wind roses there are presented statistics of the direction and force of the winds at forty nine stations well distributed over the empire The stations were selected with due regard for the reliability and the length of their records The average length of record was 20 8 years In the original observations the force of the wind was estimated according to the Beaufort scale—not observed instrumentally—but the data have been reduced to equivalent values in meters per second Comparatively few meteorological stations in Germany have anemometers and the records made by this instrument are apt to be looked upon with less favor by German meteorologists than the estimates of experienced observers, the latter being based on the movements of smoke or low clouds and therefore being freer from local influences than the readings of most anemometers

This work which in its scope and purpose is a novelty in scientific literature is analogous to the sailing handbooks and pilot charts prepared for the benefit of the navigators of the ocean It shows for each station and for each season of the year, how often on an average the wind blows from each of eight points of the compass and the average frequency of the several degrees of wind force from a calm to a hurricane

Besides its utility in indicating when and where aerial voyages may most safely be undertaken and the probable drift of non dirigible and low powered air craft it will be especially valuable in pointing out the best locations for airship sheds The operation of housing a huge airship such as the 'Zeppelin,' in a high wind is so difficult and dangerous that places having a high percentage of stormy days in the year cannot at least in the present stage of the progress of aeronautics hope to become great "air ports" (if we may coin a word analogous to "seaport") In general places near the seaboard are unsuitable for this purpose but Dr Assmann's statistics show that quite a surprising number of inland stations are so stormy that aeronauts will do well to avoid them It is interesting to discover that Friedrichshafen, where Count Zeppelin's great airship sheds are situated—one of them floating on Lake Constance—is by no means a favorable place for such structures having a yearly average of 24 1 stormy days compared with 2 2 days at Celle 4 days at Berlin and Cassel and less than 10 days at seven other stations

A remarkable railway bridge is that known as the Assopus Viaduct on a new line extending by way of Demirli to the Turkish frontier This bridge, situated in a gorge which is 330 feet deep and about 600 feet wide connects two tunnels which open from either side of the gorge The construction of this portion of the railway was on a gradient of 1 9 per cent and there is a curve of 4 per cent between the two tunnels The bridge which was built by the Société des Constructions des Batignolles, consists of a main span of 262 feet rising 78 feet and five latticed trusses, each 86 feet in length Four of the trusses are on one side of the arch, and the remaining one on the other Three of the four trusses are supported on masonry piers the fourth resting partly on the third pier and partly on the upper portion of the arch The fifth truss is supported on the other side of the arch and the entrance to the tunnel The arch is constructed of two trussed ribs which are hinged at the springing and at the crown, and the arch ribs are riveted trusses. All the steel work was built at shops in Paris.

SUBSTITUTES FOR RUBBER.

ARTIFICIAL COMPOUNDS.

The present demand for India rubber naturally directs attention to those articles which to a greater or less degree may serve to replace rubber in its industrial applications, and so help in conserving the supply.

Of such articles a very large number have been proposed. Those in actual use to any considerable extent are however relatively few. For present purposes the various surrogates may be distinguished as (1) rubber substitutes proper, consisting wholly of ingredients other than rubber; (2) composite or artificial rubbers, which contain a certain proportion of natural rubber worked up with other substances, and (3) true synthetic rubber, namely a product containing the rubber molecule synthesized in the laboratory or factory by chemical means *from simpler compounds*.

At present the first of these classes is commercially the most important. Scores of recipes are in existence, including very diverse ingredients, but the basis of most is a modified oil. At first sight there seem little suggestion of India rubber in the properties of an ordinary vegetable oil, but a simple experiment will indicate the kind of modification which certain oils readily undergo, and which help to fit them for use as rubber substitutes. If we test the drying properties of boiled linseed oil by spreading a little of it over a slip of glass and allowing it to dry, a film of oxidized oil is eventually obtained having a certain modicum of toughness and elasticity. The liquid oil has taken up oxygen and thereby become converted into a more or less elastic solid. Tung oil substitute is essentially such an oxidized product, manufactured by heating the raw oil until it has absorbed enough oxygen to cause it to thicken and become solid on cooling, when it is powdered and worked up with a little petroleum.

In a somewhat similar way the oils can be made to take up sulphur, becoming thereby solid and endowed in some degree with elastic properties. The treatment is analogous to the vulcanization of rubber. Brown or black substitutes are manufactured by heating the oil with sulphur, a process corresponding to the "hot cure" method of vulcanization. White substitutes may be made by merely mixing the oil cold with 20 to 40 per cent of sulphur chloride, or better by first dissolving the oil in a suitable solvent such as carbon tetrachloride. This resembles the "cold cure" process used in vulcanizing rubber. Colza oil is largely used for these purposes, but various others are available, linseed, maize, arachis, and castor oils, for example. The chemical reaction involved is a somewhat *complicated one*, but probably it consists mainly in the formation of what chemists term an addition product. The proportion of sulphur taken up by the substitutes varies rather widely, ranging from 5 to upward of 15 per cent. As would be expected, oils which have previously been oxidized to a notable extent (e. g. blown oils) require less sulphur to saturate them than do the natural oils.

Nitrated oils are also used as the basis of some rubber surrogates. Thus one well known product is a solution of a nitrocellulose in linseed or castor oil which has been nitrated by treatment with a mixture of nitric and sulphuric acids. Other such articles are made by oxidizing the nitrated oil with lead peroxide or by simply heating it in air.

These oxidized, sulphured, and nitrated oils in one form or another are largely used as substitutes for rubber. Of the other substitutes proposed a few examples may be given to indicate something of their general nature.

First there are those which, while still retaining oil as one ingredient, include also other important *constituents. Thus Fenton's rubber is a mixture* of oils with tar, pitch, and creosote, which mixture when digested with nitric acid gives a toughened mass, and this on heating yields an elastic product simulating rubber. A Russian substitute, said to be useful for covering *telegraph cables*, contains as ingredients wood tar, hemp and linseed oils, ozokerit, spermaceti, and sulphur. Oxolin is made by impregnating fibrous material such as jute or hemp with linseed oil, oxidizing the oily mass with warm air, and working the product up between rollers into a coherent mass which can then be vulcanized by heating it with sulphur.

In another category of substitutes oil plays only a subordinate part, or is altogether dispensed with. Thus Jones's substitute is stated to be made from various *gums and gum-like products as the chief constituents*. In W. H. Perkin's patent (23,031/07) gelatine or glue is dissolved in creosote and then treated with some reagent—potassium bichromate, formaldehyde, or tannic acid—which will render the gelatine or glue insoluble after setting; the mass obtained is digested with acetone to make it firmer. Textiloid has for its ingredients various resins, nitrocellulose, and camphor. As a curiosity in this class may be mentioned grape rubber, produced from the skins of grapes by means of pressure. It is not, however, a commercial article. Finally, though this can only be a substitute for rubber in very hard articles, we may mention the interesting material bakelite recently introduced by Dr. L. H. Baekeland. It is a condensation product of formaldehyde and phenol which can be molded as desired and afterward hardened.

In what sense are the foregoing articles and their likes to be considered as substitutes for rubber? Some persons are disposed to deny them any right to the title, and would look upon them as mere adulterants whenever used partially to replace rubber in what would otherwise be an all-rubber article. Others admit, though sometimes grudgingly, that there is a place which such substitutes can usefully fill. Much depends on what the article is sold as and on what use it is to be put to. Not all the special qualities of rubber are wanted in all the products for which it is employed. A door mat is one thing, a bicycle tire quite another. Where a high degree of elasticity is not really needed, as for instance in waterproof goods and electrical insulating work, there is a legitimate field for substitutes which may serve the required purpose. Even here they may not be equal to rubber, but they find their justification in their lower cost. After all, we do not need razors to cut sticks with.

It may be said at once that no substitute is equal to rubber in every respect. Chemically the latter is a very inert substance, much more so than the substitutes. Hence even if the latter were not otherwise inferior they would be less durable than rubber under certain conditions. They are nearly all acted upon more or less readily in circumstances where rubber remains unharmed. The modified oils in fact are still oils in the sense that they remain glycerides decomposable by alkalies, as also by steam under pressure. If used for articles exposed to these agencies *they fall in durability, whatever their excellences* otherwise.

The fact that substitutes of this class are readily saponifiable by alkali makes it an easy matter to detect them by analysis when compounded with true rubber. As a rule the proportion of substitute used is from 5 to 25 per cent, and even the small quantity is recognizable.

Of the composite rubbers (or "artificial rubbers" as they are sometimes called) one preparation which has been made in quantity and is said to be excellent *for many purposes* has for its basis Guayule rubber incorporated with certain gums. Another such article is compounded of natural rubber and some other substance of vegetable origin, probably a latex or a gum reputed to contain the same chemical elements as rubber and in much the same proportion. Such articles are of course only partially substitutes for rubber, and their cost rises with that of the latter ingredient. Moreover, if any very large demand for them arose, there is always the possibility that the supply of gums and latices would become insufficient, and the advantage of lower cost would thus tend to disappear.

Coming now to true synthetic rubber, the question often asked is whether there exists any probability of such an article being manufactured and displacing *natural rubber either wholly or to any large extent*. Will rubber plantations go the way of madder fields and indigo cultivation? Well, the future is on the knees of the gods. In the face of the precedents just mentioned, to say nothing of others, he would be a bold man who would venture to say that even the best quality of rubber may not some day be made on a commercial scale from cheaper materials such as beet sugar and calcium carbide. But the day is not yet. There are beginnings, there are clear indications of the direction in which to proceed, there is distinct *progress to note. But there is still some distance to* go, and the end of the journey may not be even in sight.

India rubber chemically is essentially a polymerized terpene. An article patented some time ago and named "turpentine rubber" appears to foreshadow a synthesis of true rubber. Turpentine is a mixture of terpenes, and the article in question was to be obtained by passing turpentine through a hot tube and treating the resulting vapors with hydrochloric acid. The result is a solid condensation product, and the idea at the base of the process appears to be the production of polymerized terpenes having some of the elastic properties of rubber.

A more promising, because a more scientific way is that outlined in Heinemann's patent No. 21,772 of 1907. Here a true synthesis is attempted. It is based upon the well-known fact that rubber is probably a polymer of the hemiterpene isoprene. The first step is the production of the unsaturated hydrocarbon divinyl, $CH_2 = CH \cdot CH = CH_2$. This is obtained by passing mixed acetylene and ethylene gases through a heated tube. With methyl chloride divinyl yields isoprene [methyl divinyl $CH_2 = C(CH_3) \cdot CH = CH_2$], and the isoprene on treatment with strong hydro*chloric acid is converted by a union of molecules into* a substance closely resembling caoutchouc, if not identical with it. The raw materials, so to speak, are thus acetylene, ethylene, and methyl chloride, which are themselves obtained by any of the ordinary methods, e. g. from calcium carbide, alcohol, and beet sugar residues respectively.

The question is, can this or some other comparatively simple synthesis, theoretically quite possible as a laboratory operation, be translated into a practicable and profitable mode of manufacture on a large scale? *One of the first doubts to arise is whether the* synthesized caoutchouc will have the physical properties of natural rubber, or whether these by any course of treatment can be imparted to it. This doubt resolved, there comes the question of economical production in competition with the natural product. Much time and thought have been spent on the problem of synthetic rubber, and it is safe to conclude that there will yet be many a headache before it is solved. Judging by what is known to have been done, rather than by the promises, rubber planters may for the *present sleep peacefully in their beds.—Nature.*

The recent disastrous accident on the Canadian Pacific Railway, the fatalities in which were augmented by the fire occasioned by the gas used for lighting the carriages, is, according to the Electrical Review, evoking the liveliest expressions of disapproval in Austria as regards both the use of gas on trains and the official ignoring of the claims of the electric light. In four recent railway accidents on the Continent the death roll was increased by the fires which ensued, occasioned by the ignition of the gas from the carriage lighting apparatus. Notwithstanding this, the Ministry of Railways is steadily proceeding with the introduction of the incandescent gas system on all the State Railways, which are expected to be completely equipped with this system of illumination by the end of 1914. Two members of the State Railways Council—*Herren Rosche and Kareis*—have *moved resolutions* and taken other action in the Council in favor of the substitution of electricity for gas on the State Railways, and it is very unlikely that the government can long ignore the drift of public opinion in this connection. It is noteworthy, our contemporary states, that electric light is already provided on the Nord Bahn and the Aussig-Teplitzer and the Buschtiehrader railways, and on the Royal Mail trains, where its use is being extended, so that the official railway world is not without practical acquaintance with its advantages.

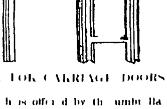
According to Concrete a separate unit type of reinforced concrete wall construction was used last year in building the power house of a small hydro-electric plant at Newton Falls, Ohio. The pilasters are of monolithic concrete, while the walls between them are hollow and are built of inside and outside thin concrete slabs which were set before the pilasters were poured so as to be keyed into them. The slabs were reinforced with No. 28 gage expanded metal, and were made in sizes that could be handled conveniently. Their outer surfaces were corrugated by laying [illegible] inch round rods in parallel lines on the surface of the fresh concrete when the slabs were cast and pulling them out after the mixture had taken its initial set. The corrugations were designed to give a good bonding surface for the plaster coat which was applied to the walls after they had been erected. The slabs were allowed to cure and were then placed on edge in proper position. Vertical form boards were placed for the pilasters extending beyond the surface for the monolithic work so that the slabs rested against them. The inside faces of the pilasters were molded against form boards placed in the air space between the wall slabs and were wired to the outside forms after the pilaster reinforcement had been placed. The inside boards also acted as spacers to keep the slabs the proper distance apart. This distance varied somewhat, but 6 inches was the minimum.

MECHANICAL ODDITIES.*

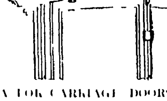
CLEVER INVENTIONS.

AN UMBRELLA FOR CARRIAGE DOORS

It is almost impossible to alight from a carriage in a shower without getting wet, for there is always a break between the shelter afforded by the carriage and that which is offered by the umbrella, which cannot be opened inside the vehicle. A French inventor has devised a peculiarly shaped umbrella, which is attached to the carriage over the door and which is spread out like a fan by the opening of the door so that it forms a roof which shelters the passenger during and after alighting. The device can be attached to the carriage very quickly and easily in rainy or threatening weather and removed when there is no occasion for its use.



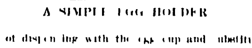
UMBRELLA FOR CARRIAGE DOORS OPENED



UMBRELLA FOR CARRIAGE DOORS CLOSED

A SIMPLE EGG HOLDER

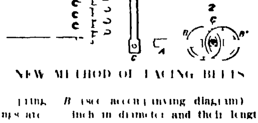
For some inscrutable reason egg cups and especially their bases are invariably made too small so that children and maladroit adults often overturn them, thereby wasting good food and soiling the tablecloth. A wise Frenchman has hit upon the happy idea of dispensing with the egg cup and substituting a piece of iron wire with one end bent into a double ring which holds the egg securely and the other end bent into a helix, the spirals of which firmly grip the edge of the plate, as shown in the illustration.



A SIMPLE EGG HOLDER

NEW METHOD OF LACING LEATHER BELTS

An original and very practical method of joining the ends of a leather belt has been devised by a French automobilist whose car is lighted by electricity produced by a dynamo which is connected with the motor by a belt. The difficulty of removing and replacing a sewed belt led to the invention of the new method of joining the ends. The junction is effected by means of an iron pin C and two spiral



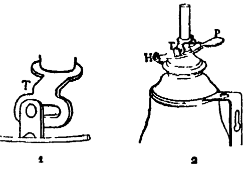
NEW METHOD OF LACING BELTS

wire springs, B (see accompanying diagram). The springs are [illegible] inch in diameter and their length is equal to the width of the belt when they are stretched so that the distance between adjacent turns of wire is 1/8 or 1/10 inch. After being thus extended the springs are covered with rouge and pressed on the belt with 1/8 inch of each end. Each turn of wire marks a red dot and care is taken to make the dots on one end of the belt alternate with those on the other end. One end of the belt is then perforated at each dot and one of the spiral springs is passed through the perforation in the manner illustrated in the left-hand diagram. The second spring is attached to the other end of the belt in the same manner. The ends of the belt are then brought together so that the springs interlock and the pin is inserted in the space inclosed by both springs in the manner shown in the right-hand diagram. The tension of the strap is usually sufficient to keep the pin in place, but for greater security the end of one of the springs may be passed through a hole in the end of the pin. This very simple method deserves to be adopted on all automobiles which have dynamos driven by the motors by means of belts.

LAMP WITH INSTANTANEOUS REGULATOR

The ordinary kerosene lamp is regulated by means of a rack which raises or lowers the wick, but this device sometimes fails to work perfectly, particularly when the wick is not long enough to reach the bottom of the oil pot. In some lamps the exposed portion of the wick can be lengthened or shortened and the flame regulated by raising or lowering a tube which surrounds the wick holders. F. Louve has constructed a lamp of this type in which the regulation can be effected instantaneously and, if necessary, with the same hand in which the lamp is carried.

As the illustration shows, the lower end of the



LAMP WITH INSTANTANEOUS REGULATOR

sliding tube carries a loop (T) which engages with a pin in the middle part of the lever HP, which turns on a pivot at H.

The lever is so placed that its free end (P) can easily be raised or lowered and the lamp regulated by the thumb of the hand which grasps the handle of the lamp. In addition to various other uses this lamp should be of service to photographers, who often require to begin developing a plate with a very faint red light and to increase the illumination as the image becomes visible.

A CIGARETTE SAFE

Cigarettes kept in an open box often disappear with surprising rapidity, leaving neither smoke nor ashes. This phenomenon is not observed when the cigarettes are kept in a secret box or safe which can be opened only by the owner. A French inventor has devised a safe which need not be opened every time a cigarette is wanted. By pressing a button a drawer is caused to open and present one cigarette (Fig. 1). The simple mechanism of the box is shown in Fig. 2. The cigarettes rest on an inclined plane above the drawer A, in the front of which, at the base of the inclined plane and at the end of the box opposite to the push button T, is a groove which is just large enough to contain one cigarette. When the button is pressed, the rod to which it is attached is forced downward through the tube H until it strikes the bent lever B, by which the drawer carrying the single cigarette is pushed outward. When the finger is removed from the button the drawer is closed by a spring and another cigarette rolls into the groove. To insure the safety of the cigarettes it is merely necessary to remove the button and its rod, which are not fastened in any way. When it becomes necessary to open the box in order to refill it an oblique pressure is applied to the button, causing the rod to slip past the lever B and strike the lever I, which opens the catch C by which the cover of the box is fastened. When the cover is closed this catch is locked by a spring.

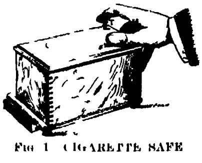


Fig. 1. CIGARETTE SAFE.

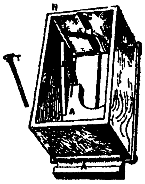


Fig. 2. THE SAFE OPENED.

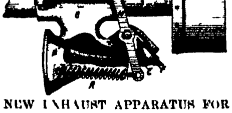
ROTATING COLOR DISK

It is difficult to give young pupils an understanding of the manner in which the superposition of two colors produces a third color. The physical laboratories of universities possess the apparatus required for these demonstrations, but the primary school teacher is often thrown upon his own resources and compelled both to construct and to turn with his own hands the color disks by which the laws of the composition of colors can best be illustrated. A very simple apparatus, which is both interesting as a toy and useful as a means of instruction, has lately appeared in Paris. It consists of a metal frame carrying a multiplying train of geared wheels which transmit power from a crank to an arbor upon which various color disks can be fastened. A set of color disks accompanies the apparatus.

ROTATING COLOR DISK

NEW EXHAUST APPARATUS FOR AUTOMOBILES

The smoke-suppressing exhaust apparatus for automobiles herewith illustrated has been found very efficient. It consists of a hollow cast iron vessel b, which is fastened over a hole in the exhaust pipe by two iron bands and which contains a funnel p, the mouth of which is directed forward. The after ends of the funnel and the chamber B can be closed simultaneously by two concentric clack valves e and f, operated by pulling the cord p attached to the lever NF. When the cord is released the valves are opened by the spring R. When the valves are open the draft of air through the funnel produced by the forward motion of the car is increased by the aspirating action of the exhaust gases, which flow backward through the space A around the funnel. The hot products of combustion are thus immediately and intimately mixed with a large volume of air, and the smoke is almost entirely suppressed.



NEW EXHAUST APPARATUS FOR AUTOMOBILES

The value of picture postcards to an engineer may not appear very marked at first thought, but in a paper before the municipal engineers of the city of New York on improvement of the appearance of municipalities Mr. Charles W. Leavitt, Jr., stated that many valuable hints as to the design of structures from the æsthetic point of view might be gained at a very small expense from a study of the French, Italian and Austrian postcards. He advised all engineers engaged in the design of public works to form a collection of these cards on account of their information regarding harmonious and pleasing design. While in Paris he obtained several thousand cards showing views of the French streets, parks, lamp posts, bridges, buildings, drinking fountains, and other structures which help to make or mar a city's appearance, and these cards have been of considerable assistance to him in his practice in America by furnishing suggestions for the treatment of public works.

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* La Nature.

THE DESIGN OF AEROPLANE MOTORS.

A CRITIQUE OF ENGINES.

The advent of the aeroplane has created a demand for internal-combustion engines of extreme lightness, and to meet this there have been produced a set of designs differing in many ways from any previously used. It is therefore interesting to consider to what extent the requirements of an aeroplane differ from those already satisfied by existing light motors, and how far the ordinary engine must be modified to comply with them.

Comparing the aeroplane with the motor car and motor boat, it is evident that while lightness is desirable for the latter two, it is an absolute necessity for the former; that is to say, a motor car or boat with a heavy engine will at all events progress at a certain speed, though not so well as if the motor were lighter, but an aeroplane will not fly at all unless the weight of the motor be kept down to a very moderate amount. In practice in the motor boat and car engines are nearly always for obvious reasons made as light as they can be consistent with their fulfilling other requirements, such as durability and reliability. Generally speaking, however, lightness and durability are opposed qualities, and the more reliable a machine is required to be, the heavier it must be also. Hence in any particular case the extent to which lightness can be sacrificed to durability or *vice versa* depends on the purpose to which the machine is to be put.

The case most akin to the aeroplane is that of the racing boat or car. In the latter case the car is only required to run one or two races and is then put on the scrap heap, and the problem is therefore simply to make an engine which will last this time and develop the maximum possible power for the period. A great many cars have been built in which the limit of size was simply a weight limit, and it may be taken for granted that the winning cars represented the lightest possible construction consistent with the required reliability. In motor boats the same thing applies, winning being almost entirely a question of weight and horse-power. In both these cases money has been of far less importance than it is likely to be in the case of the aeroplane. It will therefore be seen that the problem of a light engine is nothing new.

There are, however, several essential differences between the requirements of a car or boat and those of an aeroplane. In the first place the aeroplane builder appears at present to be willing to put up with much less reliability than the racing boat man. This is because in making records the start takes place when the motor is ready, whereas in a race it takes place at some determinate time, and if the motor be not ready then the chance is lost. The record is also the result of frequent trials, a race is gained or lost in one. Thus if one motor will make an aeroplane fly 50 miles whenever required and without unreasonable tuning up, but another makes it fly 100 miles once out of ten tries, the latter takes the record, though on its nine failures it may have broken down in a few miles, and may have required hours' tuning up for each trial. If, however, the aeroplane is ever to be of the slightest practical use, the reliability of the engine must not only be brought up to that of the racing car, but very much beyond it. In one important respect the aeroplane engine is much more like the boat engine than the car engine, as it must maintain its full power the whole time it is running, whereas the car engine seldom averages more than half its maximum except on a track.

The greatest difference is, however, that the boat and car engines must be made so that they can be got at in place, and are practically only accessible from the top, whereas the aeroplane engine must generally be got at from all round. Thus the only practicable arrangements of cylinders in the boat are the vertical and diagonal, and in a car perhaps in addition to these the horizontal, while in a flying machine radial arrangements of cylinders are permissible.

Taking the question of the number of cylinders first, there is a very great diversity of opinion, the actual number used varying from two to sixteen. Weight being the most important factor at present, the main question is: What number of cylinders will give the lightest engine, a constant factor of safety being, of course, assumed?

Considering this from a theoretical standpoint, the matter depends to a certain extent on the arrangement of the crank case, some arrangements being more favorable to a large number of cylinders than others. The actual weight of the cylinders themselves seems for moderate powers to be little influenced by their number. The whole question is, How far are the revolutions limited by the size of the cylinders? If a constant piston speed be assumed, the power of cylinders of different sizes only increases approximately as the square of their linear dimensions, while the weight increases as the cube. If run at constant revolutions, however, the power and weight would both increase as the cube. In practice it appears from the results obtained from racing engines that the possible revolutions are nearly constant for all engines up to 10 inches stroke at all events, and that the power increases at least as the cube of the linear dimensions. This being so, the weight of the larger cylinder should be less in practice for a given horse-power than that of a greater number of smaller ones, as it will be difficult to reduce the thickness of the cylinders in proportion to the reduced dimensions, and even if this be done there are some parts, such as the water jacket, etc., which it will be quite impracticable to reduce with the dimensions of the cylinder.

In practice there is also the fact that on the whole it is much easier to make an engine with a few large cylinders run well than one with a very large number of small cylinders—that is to say, the latter type is much more liable to have fits of running badly. Hence in the long-distance road races the engines with more than four cylinders have had very little success, and in many cases in the smaller classes two-cylinder and even one-cylinder engines have been most successful. In motor boats the same thing applies to all powers under about 100 horse-power. Less than two cylinders can hardly be used owing to the difficulty in balancing, but the two-cylinder opposed engine seems a quite satisfactory arrangement. The three-cylinder engines used on the Bleriot aeroplanes have also done well.

A point in which the multi-cylinder engine is distinctly superior is the evenness of turning moment. With less than four cylinders some sort of flywheel is necessary, though where the propeller is direct coupled it also serves as a flywheel. Four cylinders theoretically will not run at all without a flywheel, as the drive is not continuous, but with more cylinders the drive becomes continuous. While this should be a distinct advantage to the transmission gear, it must be remembered that with many cylinders there is always a great liability for one of them to cease firing, in which case the reversal of stress is nearly as great as with fewer cylinders.

With an ordinary arrangement of cylinders, therefore, it seems as if there would be no advantage in substituting a large number of small cylinders for a few large ones. Capacity for capacity the larger cylinders should give more power and weigh slightly less, while the accessories, piping, etc., should weigh very distinctly less. There are, however, several arrangements by which a large number of cylinders may be grouped on to a very light crank case, and this may produce a light engine owing to the saving in weight in the latter. The weight of an engine consists principally of the cylinders and pistons on the one hand, and the crank chamber, crank shaft, etc., on the other. Roughly speaking, with any given arrangement of cylinders the weight of the latter will be proportionate to the cube of the dimensions. That is to say, that if the cylinders are arranged vertically in a row, for instance, the weight of the crank case, shaft, etc., will be practically proportionate to the cylinder capacity. If we can mount the cylinders in such a manner that we can get a great cylinder capacity with a very short crank case, we shall, however, save weight. If, for instance, we start with the vertical four-cylinder engine of the ordinary type, as shown in Fig. 1 on the previous page, the crank case has necessarily to be as long as the length over the cylinders. In this and the accompanying figures the valves are omitted for the sake of clearness, and in all the figures the cylinders are the same size, so that the size of crank case necessary for a given cylinder capacity can easily be seen.

Two common plans for reducing the length and weight of the crank case are to place the cylinders either diagonally, as in Figs. 2 and 3, or horizontally opposed, as in Fig. 4. In either of these arrangements the length of the crank case, etc., is almost halved, and a considerable saving of weight is effected. Either of these arrangements can be made with two, four, six, eight or more cylinders. In the case of the

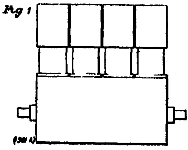


Fig 1

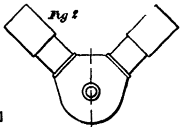


Fig 2

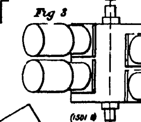


Fig 3

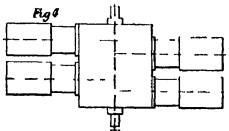


Fig 4

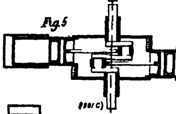


Fig 5

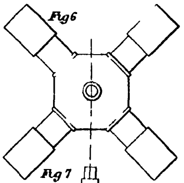


Fig 6

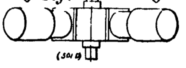


Fig 7

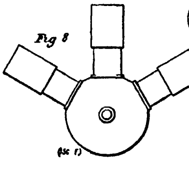


Fig 8

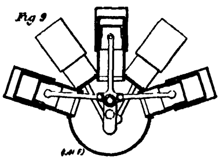


Fig 9

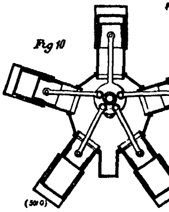


Fig 10

diagonal engine the impulses are not evenly divided with two or four cylinders, though they can be so with six if the angle between the cylinders be made 120 deg. With eight cylinders at 90 deg. the impulses are evenly divided, and this is the most usual number. In this type each diagonal pair of cylinders is connected to one crank. The diagonal engine with the cranks at 90 deg. can be balanced for all practical purposes, even where there are only two cylinders, by placing a balance weight opposite the crank equal to the weight of the whole rotating parts and the reciprocating parts of one cylinder. With four cylinders the cranks are usually placed opposite, but balance weights are still necessary to avoid a rocking moment. With eight cylinders the cranks are set so that the two end ones are opposite to the two middle ones, and no balance weights are required.

In the case of the opposed horizontal engine the two connecting rods work on opposed cranks, as in Fig. In this case the engine, even when the two-cylinder, is in many ways better balanced than the vertical or diagonal types, as the errors in balancing due to the angle of the connecting rods is allowed for. If only two cylinders are used there is, however, a very small rocking moment due to the fact that the cylinders are not actually opposite each other, but this is usually a negligible quantity. It has in some cases been eliminated by putting the cylinders exactly opposite and the connecting rod out of line with the little end, but this remedy seems worse than the disease. With four cylinders the rocking moment is balanced. The impulses in the horizontal opposed engine are always evenly divided, whether two, four, or eight cylinders are used.

Comparing the horizontal opposed with the diagonal engine, the former appears to have all the advantages, as the impulses are more even with a small number of cylinders and the balance better. The latter point will enable somewhat shorter connecting rods to be used without excessive vibration, thus lightening the engine. It seems also a distinct advantage of the horizontal opposed engine that the two cylinders can be connected by bolts running right through from the flange of one cylinder to that of the other, and thus the whole of the crank chamber can be in compression and be made much lighter than if any of it had to bear tensile stresses.

While the crank case, etc., is distinctly lightened by these arrangements, it can be still more reduced if the cylinders are all arranged radially on to one crank. This has been done in a great many different ways by different makers. In order to compare with the previously mentioned four-cylinder engines, a four-cylinder radial engine is shown in Figs. 6 and 7, the cylinders being the same size as before. It will be seen that in this case the crank case and shaft are very much shorter and lighter than in any of the previous arrangements. In practice four cylinders is not a good number, as the impulses cannot be evenly divided, and an odd number of cylinders must be used to effect this. This type of engine can be satisfactorily balanced as long as the cylinders are evenly spaced round the crank case, for all the pistons are attached to one crank pin, and therefore form one revolving weight, which can be balanced by a suitable balance weight.

While this type seems theoretically the lightest there are several disadvantages to be overcome in making it satisfactory. In the matter of weight there is the difficulty that if the cylinders are water jacketed each cylinder must have a separate jacket and water connections. Where there are several cylinders close together and parallel they can all be inclosed in one water jacket, and this will be lighter than taking a separate jacket round each cylinder, while it will also only require one set of water connections. In this the ordinary vertical engine has a very distinct advantage. The diagonal and opposed engines can, however, have all the cylinders on one side inclosed in one jacket, but the radial type must necessarily have them all separate. Numerous water connections not only weigh a very considerable amount, but also introduce more chances of breakdown through failure. On the other hand, if air cooling be used, the radial type is far the best, for the cylinders are so far from each other that they will not radiate heat to each other, and they do not screen each other from the draft of the propeller.

Where many cylinders are used it is impracticable to actually put all the connecting rods to work onto one crank pin, as either the big ends would have to be very narrow or the crank pin impracticably long. This can, however, be got over by the arrangement shown in Fig. 10.

Probably the greatest difficulty in making the radial engine satisfactory is that of lubrication. This is a matter which does not seem to have had nearly as much attention paid to it as it needs, and many of the aeroplane engines rely solely on splash for their lubrication. In this case the even distribution of the oil to the various cylinders of a radial engine is very difficult, and further, however well it might be managed when the engine was running, directly it stopped the oil would all run into the lower cylinders and probably foul the plugs, so that it would be difficult to start it again. In order to get over this the engine has occasionally been laid on its side, with the crank shaft vertical, driving the propeller through bevel gear. If it is desired to run the propeller slower than the engine there is no great objection to this, and there is little doubt that the slow-running propeller is much the more efficient. Another plan is to modify the arrangement of the cylinders. Thus in one make of three-cylinder engine the cylinders are all at the top of the crank case (Fig. 8), all the connecting rods leading on to one crank pin. In this case it is impossible to divide the impulses evenly, and the balancing is not so good. In practice this type of engine is made with inside fly wheels of considerable weight, and runs well, but the fly wheels necessarily add to the weight. Another plan is to put all the cylinders at the top of the crank case, and to place those which would have been at the bottom in a complete radial engine on a crank opposite to the others, as shown in Fig. 9.

A comparison of this arrangement with Fig. 10 will show that it is really a five-cylinder radial engine with the two bottom cylinders moved to corresponding places at the top of the crank case and attached to *an opposed crank. The division of the impulses* will be the same as in the complete radial engine, and the balancing nearly as good, but the crank shaft must be larger in diameter, owing to its weaker form, and as both it and the crank case are longer they will be considerably heavier. The cylinders are also so close together that air cooling will be much less effective. Even with all the cylinders above the crank case it does not appear that splash lubrication will distribute the oil at all evenly to all the cylinders. The action of the crank pin or fly wheel will be to produce a flow of oil round the crank case, and the first cylinder will obviously intercept the greater portion of this. No doubt if enough oil be used there will be a good deal distributed indiscriminately by the crank pin, etc., but this will not prevent the first cylinder getting more oil than the others.

Considering the fact that aeroplane engines are run at very high revolutions, and that the bearings have to be as small as possible to save weight, it seems certain that they should be fitted with a good system of forced lubrication, whatever their arrangement may be. In this case there seems no reason why the complete radial engine should not be perfectly successful, as the cylinders are lubricated by oil thrown out of the crank pins, and this will be distributed evenly. Fig. 10 shows a five-cylinder engine so arranged. In this case the oil which comes out of the bearings and big ends should mostly fly onto the walls of the crank case and run directly back into the oil sump, while the small amount which goes into the cylinders cannot possibly accumulate when the engine is running, as the speed at which the pistons move is far too high for this. Oil is prevented from running down the walls of the crank case into the cylinders by a projecting rim.

In some cases the radial engine is made with the crank shaft fixed and the cylinders revolving. As constructed by the Société des Moteurs Gnome this type has given very good results, but it may be doubted whether they are due simply to making the cylinders revolve. A very small amount of consideration will show that the radial engine will be of the same weight whether the cylinders revolve or the crank shaft, all other details of construction being of course assumed to be the same. This being so, the only way in which the revolving cylinders can be an advantage is either by allowing a lighter construction of cylinder or crank case, or else by increasing the power got out of a given sized cylinder. There does not seem any reason for supposing that revolving the cylinders secures either of these results.

The advantages of the revolving cylinders are (1) That they act as a fly wheel, and (2) that they allow of more efficient air cooling. Where the propeller is direct coupled, however, no fly wheel is required in any case. No doubt there is a distinct advantage in the air cooling from the fact that the cylinders revolve, but it is not likely to be very great.

Assuming that the ends of the cylinders are 15 inches from the crank shaft, and the engine runs at 1,200 revolutions per minute, the ends of the cylinders move through the air at about 95 miles an hour. Now when the engine with fixed cylinders is placed just behind the propeller it probably always works in a current of air moving 60 miles an hour or more, so it will be seen that the difference is not so great as might be expected. In practice the power given per cubic inch of cylinder capacity by the Gnome engine is very small, and there seems no reason to doubt that the same power could be got with fixed cylinders of smaller size. The good results appear to be due to the fact that the weight of the parts is reduced by machining practically all parts, including the cylinders and crank case, from steel forgings to such an extent that the engine only weighs 0.35 pound per cubic inch of cylinder capacity. It seems probable that with fixed cylinders at least equally good results could be obtained if the same amount of trouble and money were spent. The revolving cylinders introduce numerous difficulties in construction, not the least of which are the effects of centrifugal force on the valves, etc. It is also not so easy to make a neat arrangement of a geared-down propeller.

There are several points of importance in the comparison of these various arrangements besides the weight. One is that as the length of the crank case is reduced by grouping the cylinders, the work put on the bearings is increased without in most cases any proportionate increase in the bearing surface. Thus if we compare the opposed or diagonal type with the vertical, we see that the former is very much shorter than the latter, but each main bearing in the former has to take the load due to two cylinders instead of one. In the opposed engine this comes on opposite sides of the bearings, so that if the pressure from each cylinder produces the same amount of wear, the slack produced in the opposed engine will be twice that in the vertical. This means that for equal durability the diagonal or opposed engine should have the main bearings twice as long, but in this case the crank case would become as long as that of the vertical engine, and the weight as great. With the radial engine matters are still worse, but in this case the bearings can be somewhat lengthened without actually making the crank case bigger by carrying them out on bosses.

A distinct disadvantage of the radial engine is that it may in some cases not be nearly so convenient to fix as the vertical and opposed, as the latter can have lugs on the crank case and no parts projecting below this.

On the whole, the type which seems likely to provide the best combination of lightness and reliability is the horizontal opposed, as although the crank case has to be slightly longer than in the radial type, if more than two cylinders are employed, no part of it need be in tension, and therefore it can be very light. Further, for moderate powers the engine can be made with only two cylinders, and this should make it freer from breakdown and more economical in fuel and oil. The more the aeroplane develops the greater will, however, be the importance attached to reliability, and it is quite possible that the vertical type will be eventually preferred, as in racing cars and boats. On the other hand, the radial type is no doubt theoretically the lightest, and if the difficulties of making it work satisfactorily can be overcome it may be the future pattern.—Engineering.

— —

Level-crossing elimination on the railway lines passing through built-up districts in America is so very expensive that the disinclination of railway companies to carry the work out except by installments as funds are available for the purpose is but natural. Some articles by Mr. Greifenhagen now appearing in the Engineering Record illustrate clearly the costly nature of such alteration. In the borough of Queens there are more than 00 level crossings, and in the borough of Richmond there are about 100 of these death traps. In 1908 there were 29 deaths at such places in Queens, and as the population increases the danger of them must grow. As the law now stands the Public Service Commission has no authority to compel the alteration of a railway, but must, as specific cases occur, order the street to go above or below the railway, usually at a difficult level. The law provides that the State shall pay one-fourth of the expense, but for years it has made no appropriation for the purpose, and the city cannot pay the State's proportion of the cost without obtaining special legislation. As a result of this condition level-crossing elimination is practically at a standstill, except where it is done under a special enactment, or the railway company carries out the work at its own expense.

According to the Railroad Age Gazette, some reinforced concrete sleepers which about two years ago were placed in a section of track on the West Pennsylvania lines carrying heavy high-speed traffic do not show signs of deterioration. A ⅜-inch steel casing on the sides of the sleeper, with a lap approximately 1¼ inch on the top and on the bottom, and eight strips punched out and turned into the concrete serve to hold it in position, while three flat strips across the top and the same number across the bottom are bolted to the sides to prevent spreading. Two longitudinal 1½-inch rods, one near the top and the other near the bottom, provide the necessary reinforcement. The rails rest on and are fastened to tie plates with two 1-inch bolts on each side of the base, the head bearing on the plates inside of recesses on the bottom. To insulate the rails the overlap of the metal sides is sheared off and bent into the sleeper at the tie plates. These sleepers are 7 inches thick, 1 foot wide, and 8½ feet long. This large bearing area results in a saving of sleepers, as fifteen of them take the place of eighteen of the standard wooden type, and the downward thrust is distributed over a short distance on each side of the tie by rounding the sides slightly.

A SUGGESTED IMPROVEMENT IN AEROPLANES.

VELOCITY AND STABILITY.

BY A. MELIN.

THE aeroplane in its present condition is only an instrument of sport In order to make it of practical utility both its stability and its speed must be increased or rather it is simply necessary to increase the speed as increase of stability will follow automatically The stability of all actual aeroplanes is very precarious whether it is produced by wings deformable planes or without special mechanism The reason of this instability is that the speed being low the aeroplane is affected by the least disturbance of the atmosphere A tugboat and a torpedo boat of equal tonnage behave very differently in the same sea the torpedo boat cutting through the waves and the tugboat being tossed by them An aeroplane provided with a feather would behave in the air like *an arrow on condition that the velocity is sufficient*

This is only one reason and the least important one for increasing the speed of aeroplanes The aeroplane cannot become a useful vehicle until its speed exceeds that of terrestrial vehicles With the present types we know that in order to double the speed the power must be increased eightfold Bleriot in order to gain six miles an hour was obliged to triple the power of his motor and in order to gain a little further increase of speed he found himself compelled to diminish the area of the supporting surfaces

Let us then assume an aeroplane of small area designed for a speed of 100 miles per hour But where can we find a ground on which it can be launched at such speed and how can we make a landing without the certain destruction of the vehicle and its passengers?

Hence it is absolutely necessary that the aeroplane shall be able to start at low speed and to increase its velocity very greatly during the flight For the accomplishment of these results the following means suggest themselves Increase of motive power diminution of area of sustaining surfaces during flight diminution of angle of attack We will dismiss at once the consideration of increase of motive power for this is not a real improvement but a last resort The diminution of area a solution which is very seductive at first sight appears on more careful examination to be full of difficulties and dangers As these surfaces must be made to fold they will necessarily be deficient in strength and rigidity and it will also be very difficult to maintain the curvatures unchanged Furthermore if the motor stops the operation required for extending the surface will demand an appreciable time and expense of muscular energy so that the aeroplane is very likely to strike the ground before the operation is effected Landing in such conditions would be very sudden and disastrous Hence this method must be rejected The diminution of the angle of attack remains to be considered This combined with the effacement of part of the sustaining surface forms the object of the present patent

Let us suppose a surface divided into three parts *AB BC* and *CD* (the number arrangement and curvature of the parts are however variable) Let us suppose that the bow and stern portions *AB* and *CD* are kept parallel to each other and make an angle *a* + *b* with the trajectory and that they produce an upward pressure *P* and a horizontal resistance *H* The middle part *BC* makes a smaller angle *a* with the trajectory and produces an upward pressure *P* and a resistance to forward motion *H* These values correspond to a velocity V such that the sum of *P* and *P* is equal to the entire weight of the apparatus and the surfaces are so calculated that this velocity V is as small as possible in order to facilitate starting and landing in a small space and without shock The compound surface *ABCD* is arranged to turn on an axis at *O* a short distance behind *T* the center of upward pressure By means of a lever or other device let us turn *ABCD* about *O* so as to make the middle part *BC* parallel to the trajectory As the points *T* and *O* are near together the expenditure of energy required for turning the surfaces will be small and the operation may be effected by several successive stages In the new position as the middle surface *BC* is parallel to the trajectory it does not contribute *to the upward sustaining pressure* The resistance of this portion to forward movement will also be negligible if the surface is sufficiently smooth since this resistance will then consist entirely of air friction The terminal portions *AB* and *CD* now make with the trajectory a smaller angle *b* and consequently their resistance to forward motion is greatly reduced Hence without any increase in power the speed of the aeroplane will increase to a value V greater than its initial value V The surfaces *AB* and *CD* are of such dimensions that the new upward pressure *P* which they produce at the new velocity V *is equal to the weight of the apparatus* which must now be sustained entirely by these two surfaces The ratio between these two surfaces is so calculated that the center of pressure shall vary as little as possible during the change in the angle of attack the small variations which cannot be avoided being compensated by means *of the horizontal rudder* which may be moved automatically by the change in the angle of attack

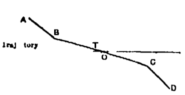


DIAGRAM ILLUSTRATING MELIN'S IMPROVEMENT IN AEROPLANES

Thus we have increased the velocity by diminishing the resistance without increasing the motive power and without affecting the stability and security In fact if the aeroplane tends to fall the middle surface *BC* will again become operative and oppose an upward pressure until the center of pressure is in front of the center of rotation If by means of a clutch controlled for example by a pedal the surface *ABCD* is released it will tend of itself to *resume its first position* in which it will produce a great resistance to forward motion which will reduce the velocity to its original value In this way landing can be effected without shock

It might be feared that in the second position in which the line *AD* representing the mean direction of the surface makes a small angle with the trajectory a downward air pressure might be produced upon the upper surface There is no such danger for the forward position *AB* still makes a considerable angle with the trajectory although the average direction of the entire aeroplane is very nearly parallel therewith Furthermore such filaments of air as may strike the upper surface as designed in my apparatus instead of producing a downward pressure will increase the sustaining power This is the well known effect of a current of air striking a curved surface tangentially For further details on this point the reader is referred to Sir William Maxim's work on artificial flight to Coupilles papers in L'Aerophile and to the Revue de l'Aviation February 1909

The forward edge may also have considerable thickness as it has in Wright's aeroplane which is certainly an excellent one and does not appear to be *affected injuriously by air currents striking the upper* surface although the forward portion is so nearly tangent to the trajectory that it appears to fly with a negative angle of attack

Theoretically other things being equal in order to double the velocity by acting only upon the area of the sustaining surface it would be necessary to reduce the latter to the ratio of 1/4 to 1 One of the advantages of my device is that I act simultaneously upon the area by cutting out the middle portion *BC* and upon the mean angle of attack Thus if the sum of the surfaces *AB* and *CD* is equal to one third of *BC and the angle of attack is diminished by one half* the velocity is approximately doubled without increasing the power —Aero Mechanique

A BOX WITH SECRET OPENING

THE box illustrated in Figs 1 2 and 3 is made to resemble a book in shape and is opened by drawing out a panel in one of its covers When closed it is not easy for a person who does not understand its construction to discover how to open it It requires to be very neatly made and the wood must be well seasoned so that it will not warp or shrink and spoil the fit of the loose panel For the same reason the smaller it is made the better for the panel must not become loose enough to slip out of itself nor must it be too tight to be drawn easily The dimensions given on the illustrations represent a convenient size but there is no reason why they should be strictly adhered to The choice of wood for the purpose may depend on what is available but hardwood should be used in preference to soft and among the common hardwoods mahogany is the least liable to shrink or warp

The simplest method of construction is to glue the sides and back on to a block which has had its central part cut out to form the interior space This block with the back glued on it is shown in Fig 3 In one side of this a thin piece of solid wood is glued to form one cover of the book and on the other strips are glued to inclose the loose panel These strips which are three in number leaving one end open are shown on the upper face of the views in Figs 1 and 2 As there is a likelihood of the panel becoming a bad fit through shrinkage it is best to get it out first plane it nearly to thickness and leave it to shrink as much as possible before it is fitted The block to which the outer parts are glued may then be squared up to dimensions and the hole which is to be cut through it, marked out on both faces This may easily be done, gaging lines from the edges and striking the small rod in the corners with dividers A center bit hole is then bored through at each corner of the marked out portion and the straight parts sawn within the lines It is then pared through to the lines with gage and chisel and tool marks removed by glasspapering Next a piece for the back is prepared

FIG 3.

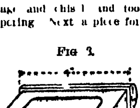


FIG. 2.

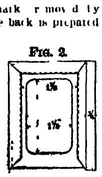


FIG. 1.

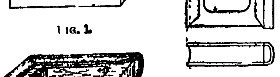


Fig 1.—View of book with panel drawn out. Fig 2.—Plan and end view of book with panel removed Fig 3. Block with hole cut through it and back glued on

and glued on This must be large enough to overlap about ⅛ inch all round as in Fig 3 and it is best not to finish it to shape as shown but allow sufficient for trimming down after the sides or covers are on Next a single thin piece of wood about ¼ inch thick the full length of a cover and of a width to extend from the glued-on back to about ⅛ inch beyond the front edge of the block will be glued on one face of the block thus covering and forming a bottom to the hole which has been cut through On the other face of the block three strips with mitered corners form a portion of the other cover and the remainder of it is supplied by the panel which slides in The edges of strips and panel must be veed so that the panel can only come out by sliding lengthwise The panel is a single piece of wood as shown separately in Fig 1 A line is scribed across its face where the mitered portion commences and the cover on the other side of the book is scribed to give the appearance of a similar panel The covers however are not exactly similar in appearance because on the side where the strips are glued the grain runs across at one end This is rather an advantage than otherwise because it shows the person familiar with it which way it opens but even when noticed by another does not solve the puzzle

The work is finished by gaging the front to a curve and rounding the back Each end of the latter is carved out as shown in Figs 1 and 2 —Hobbies

A writer in the American Machinist states that while soft soldering is not considered a very mechanical way of fastening machine parts it sometimes helps one out of a difficulty in a surprising manner Over a year ago he had to repair a lathe the main driving gear on which was very loose on the spindle The spindle was hollow and so thin that it did not furnish a good support for the key The gear spindle key seat and key were cleaned and carefully tinned They were then heated hot enough to melt the solder and assembled The lathe has been in hard service ever since and the gear is still perfectly tight He has used this method on other gears and has never had one work loose although they can be quickly removed at any time with the aid of a blow lamp

ELECTRICAL NOTES

A study of the electro metallurgy of zinc carried on by V Engelhardt and M Huth would seem to indicate that the electrolytic refining of zinc cannot profitably be carried on Copper refining yields valuable by products in the noble metals the Friedrichshütte at Tarnowitz tried for some time electrolytically to refine the residue from the zinc desilverization process after Roessing but it proved too expensive Hopfner's electrolysis of zinc chloride was not economical either although technically successful There remains the sulphate electrolysis The ore is roasted extracted with sulphuric acid the solution purified and then electrolyzed A good zinc is obtained only from pure solutions When hydrogen is evolved spongy zinc forms and redissolves in the acid set free The hydrogen may be oxidized in various ways The chief trouble is the insoluble anode Carbon is destroyed Ferchland's anodes of lead peroxide have answered in an experimental plant in Silesia but they can be obtained only in rod shape and are not durable Anodes of manganese peroxide are equally good and have lasted more than a year no zinc is redissolved even in the presence of 10 per cent of free acid Even this process however depends upon cheap power the power consumption being high

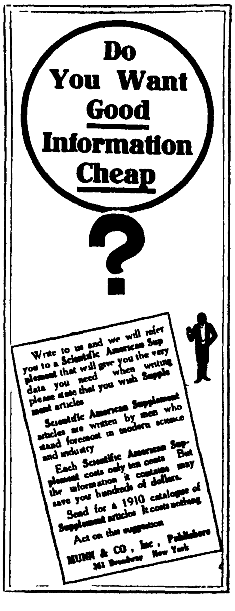
At a meeting of the Italian Society for the Advancement of Science L Barreca read a paper on the measurement of the power radiated from an antenna According to him if W denotes the power which is radiated by an antenna supplied with pure sine oscillations and I the r m s current at the base then W/I^2 a is a quantity which is shown to be independent of the dimensions for antennas which are geometrically similar Measurements (of the energy in the primary circuit) are made with and without the sending antenna the difference represents the energy radiated if that lost in heating the antenna be neglected The oscillations are derived from a hydrogen arc across the terminals of which is connected an air condenser of 0 001[illegible] mfd in series with the primary of an oscillation transformer The secondary circuit consists of the sending antenna connected through the secondary of the transformer and a hot wire ammeter to earth The watts in the primary circuit are measured by means of a Braun kathode tube with two pairs of electrodes one pair bridging the condenser and the other the arc The area traced out by the luminous spot on the screen multiplied by the frequency (n = 411 000) and the capacity of the condenser gives the energy in the circuit Purity of the oscillations in the secondary circuit is secured by sufficiently loose coupling in the primary circuit by sufficiently great [illegible] The mean of several experiments gives 212 watts with aerial and 111 without representing 101 watts radiated for a current to earth of 27 2 amps The value of a for the system used is therefore about 14 ohms with a possible error of ± 30 per cent

An electric accumulator locomotive fitted with Edison cells has been built by the firm of F Schichau for the Prussian Hessian State Railways according to the Elektrotechnische Zeitschrift The length of the locomotive over the buffers is 2[illegible] 6 feet and the cells are arranged in the usual manner on each side of the cab in water tight chambers with ventilating openings provided with dust filters The battery comprises 408 Edison cells of the H 45 pattern with a capacity of 280 amp hours each so that the average discharge pressure is [illegible]02 volts The cells are grouped in wooden crates in batches of four Each cell measures [illegible] inches by [illegible] inches by 12 2 inches high and the total weight of the battery including the wooden crates is 5 9 tons or about [illegible] pounds per cell There are twice as many positive as negative plates The plates are spaced only 1 millimeter apart and are separated by thin rectangular hard rubber sticks Hard rubber pieces insulate the plates from the containing case and the terminals from the cover which is sealed on The electrolyte is a 21 per cent solution of caustic potash The life of both positive and negative plates is said to be [illegible]3000 train miles The electrical equipment of the locomotive comprises two series motors each with a capacity of 35 horse power on the 1 hour rating and coupled to the driving axles through single reduction gearing of 1 to 4 44 The motors have series parallel control there being five series four parallel and one short circuit braking positions of the controller On account of the low supply pressure available the battery is charged in two parts the cost of a single charge with current at [illegible] pf per unit being 18 marks The total weight of the locomotive is 19 5 tons made up of 9 8 tons for the body frame and trucks 3 8 tons for the motors and switchgear and 5 9 tons for the battery On the test run, this locomotive hauled a loaded goods truck with a total weight of 36 tons over a distance of 212 5 kilometers (13[illegible] miles) on one charge which had lasted 3¾ hours At the end of the journey the battery had a terminal pressure of 468 volts so that it would have been possible to run another 50 kilometers (30 miles) Profile maps of the line are given showing the gradients and the corresponding energy consumption On the Elbing Braunsberg section the energy consumption (locomotive and one trailer of 31 5 tons) was 25 2 watt hours per ton kilometer in one direction and 18 10 in the other (downhill) On the Elbing Tolkemit section the figures were 28 0 and 13 4 watt hours per ton kilometer respectively

SCIENCE NOTES.

There are a number of illusions and constant errors of judgment which are well known in the psychological laboratory and which seem to depend not on peculiarities of the sense organs but on quirks and twists in the process of judgment A few of these have been made the matter of comparative tests with the result that peoples of widely different cultures are subject to the same errors and in about the same degree There is an illusion which occurs when an object which looks heavier than it is is lifted by the hand it then feels not only lighter than it looks but even lighter than it really is The contrast between the look and the feel of the thing plays havoc with the judgment Women are on the average more subject to this illusion than men The amount of this illusion has been measured in several peoples and found to be with one or two exceptions about the same in all Certain visual illusions in which the apparent length or direction of a line is greatly altered by the neighborhood of other lines have similarly been found present in all races tested and to about the same degree As far as they go these results tend to show that simple sorts of judgment being subject to the same disturbances proceed in the same manner among various peoples so that the similarity of the races in mental processes extends at least one step beyond sensation

Certain phenomena observed by Hale in sun spot spectra induced H A Lorentz to work out the theory of the Zeeman effect on the assumption that the direction of observation is oblique to the lines of force a problem already treated by W Voigt but in which some details remained to be examined The subject here treated is the inverse effect to which the direct one is intimately related and the discussion starts with the fundamental equation in the form in which Lorentz gave it in the Mathematische Encyklopädie supposing the magnetic field to be homogeneous and parallel to the axis of z Though on account of the complexity of its structure the mode of motion of the electrons in a particle may be far from simple it is found possible to treat them mathematically in a general way This is due to the circumstance that under certain simplifying restrictions the electromagnetic action exerted by a particle is found to be wholly determined by its electric moment Hence in considering the influence of a particle on the propagation of light it is possible to replace it by a single electron to which may be assigned an arbitrarily chosen charge e, and whose displacements, x, y and z have such values that the products ex ey and ez are equal to the component electric moments of the particle This imaginary electron may be called the "equivalent electron" Mathematical expressions for the oblique field at an angle θ are then derived which, on putting $\theta = 0$ or $\pi/2$ reduce to those of the well known theory of the Zeeman effect for directions parallel to or perpendicular to the lines of force Certain special cases are also discussed



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TRADE NOTES AND FORMULÆ.

Ointment for Burns (Lanolin Ointment) —100 parts lemon grass oil 100 parts lanolin 15 parts sugar of lead 2 parts liquid carbolic acid

Hardening Preparation for Files—For sprinkling into a file hardening apparatus the following mixture is good Horn meal 5 parts, wood charcoal dust 5 parts common salt pulverized 2 parts, nitrate of potash 0 5 part ferrocyanide of potassium, 1 part

For Protection Against Mosquito Bites—The following mixture has proved excellent 2 parts thymol are dissolved in 8 parts of alcohol then 20 drops of oil of cloves added to the mixture This must be applied by means of a cotton wad to hands neck and face

Casein Glue in Powder Form.—15 to 20 parts, by weight of dry refined casein are reduced in a pulverizing mill to a fine flour and then in a sifting and mixing device thoroughly mixed with 1 to 4 parts by weight of ground borax or with 2 to 8 parts, by weight of bicarbonate of soda Much importance attaches to a very careful mixing of the powder

Asphalt Varnish for Wooden Dishes.—Asphalt 200 parts dissolved warm in 900 to 1 000 parts of oil of turpentine (best effected in an iron pot with close lid in the water bath) When dissolved add 100 parts of elemi 100 parts yellow wax 100 parts Venice turpentine Allow the whole to boil gently for ¼ to ½ an hour and when cooled strain through a cloth

To Destroy Crows—For the destruction of crows in neighborhoods which they frequent in great flocks a confection of phosphorus flour and ox blood is recommended strychnine is not to be recommended for this purpose its effect is too rapid and the crows seeing the sudden collapse of their fellows become suspicious and soon avoid the dainty morsels

To Attach Celluloid to Metal.—The best adhesive for celluloid to metal is according to experience 98 per cent acetic acid It is however advisable to immerse the celluloid articles for about 30 seconds in the acid and then, when the upper stratum is somewhat dissolved to press it on the metal and if possible to subject it for a time to a light pressure If however we wish to make perfectly sure mix the acetic acid with some celluloid shavings so that a mixture of about the consistency of mucilage is obtained this insures the closest adhesion of the two substances

Insoluble Adhesive for Envelopes and Postage Stamps—Two solutions are required one to be applied to the inside of the flap of the envelopes one to the part of the envelope to which this is to stick The latter solution (which must not be moistened with the tongue) consists of [illegible]0 parts of crystallized chromic acid dissolved in 1[illegible]5 parts of water and about 15[illegible] parts of strong ammonia with about 10 drops of sulphuric acid 31 parts of cupric oxide of ammonia and 4 parts of fine white paper added First solution Dissolve isinglass in acetic acid (1 part acid to 7 parts water) at 212 deg F.

Polish for Pressed Brass Goods.—Substances of a slimy character that are not actually fats are better suited than soap and are more easily removed from the finished goods Water and ox gall boiled together in equal parts furnish an excellent polishing material After cooling this fluid may be corked up in bottles and when needed used in a glass or porcelain dish It should be applied with a small brush and the burnishing tool may also be dipped in it Brass articles can also be brilliantly polished with a mixture of ½ pint of buttermilk and a tablespoonful of common salt Soak a rag in the mixture and vigorously polish the object Afterward dry it off and the article will look like new

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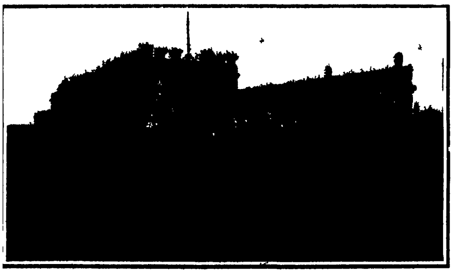
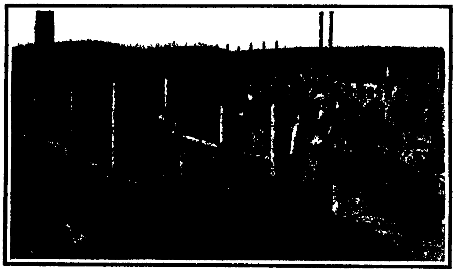
TIMGAD. CAPITAL OF A COLUMN FROM THE CAPITOL.

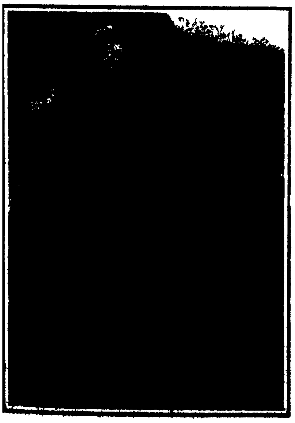
TIMGAD. OPEN AIR MUSEUM AND GENERAL VIEW.



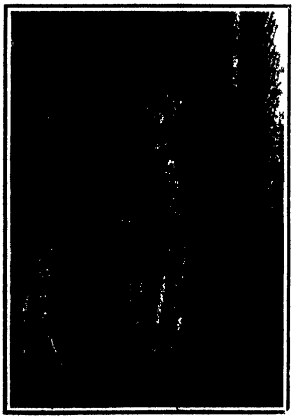
MUSEUM AT TIMGAD. THE REPOSITORY OF AN IMMENSE COLLECTION OF EXCAVATED STATUES, SARCOPHAGI, CAPITALS, ORNAMENTS, ETC.



TIMGAD. HOUSE OF THE BATHS. IN THE BACKGROUND IS THE CAPITOL WITH ITS TWO COLUMNS STANDING.



STATUE OF AN EMPEROR IN THE ROMAN THEATER AT PHILIPPEVILLE.



A MARBLE STATUE OF ABUNDANCE FOUND IN THE FORUM IN THE RUINS OF TIMGAD.

ROMAN RUSICADA AT PHILIPPEVILLE.

NEW FINDS IN THE NORTH AFRICAN REGION.—[SEE PAGE [illegible]]

THE ART OF ENAMELING.*

VITREOUS ENAMELING OF CAST IRON FOR INDUSTRIAL PURPOSES.

BY HAROLD HOLCROFT, M.A., F.R.P.S.

Up to the present time enameling has been treated as a secret process but seeing that much of the practice of enameling is now common knowledge the time has arrived when the subject can be discussed by those interested with advantage to all One difficulty in the way of research which involves any considerable expense is the fact that the trade is but a minor industry and perhaps likely to remain so

Until recently the literature of enameling for industrial purposes only existed in the specifications of patent offices or in scraps of no great importance in general literature Silicates are now receiving attention not only in their application to ceramics and glass but also to some extent in their application to enamels on metals and reports thereon are to be found in the transactions of the American Ceramic Society A summary of recent work in Germany in the field of silicates has been published by Dr Koerner in the Sprechsaal Kalender für die keramischen Glas und verwandten Industrien (Muller und Schmidt Coburg)

The application of vitreous enamels to cast iron is probably of French or German origin and dates from a time earlier than the beginning of the last century Tradition asserts that cast iron vessels were enameled in Alsace and Lorraine about this time and probably also in the Rhine provinces of Germany

In this country a patent was taken out by Hickling in 1799 and enameled cast iron pots were made under this patent at the Eagle Foundry in Birmingham This enamel appears to have been applied in one coat and to have contained a considerable percentage of lead compounds The manufacture was abandoned after a short existence

In 1839 T and C Clark of Wolverhampton took out a patent for a process in which the use of lead was avoided This enamel consisted of two coats the lower coat being a borosilicate of relatively high fusing point and the upper a more fusible glaze The idea of using two coats with the upper the more fusible of the two appears to have originated on the Continent but Clark's process was a marked advance in that the quality of the goods was much superior and the use of lead in the enameling of cooking vessels dispensed with In the manufacturing process Messrs Clark received great assistance from C Machin the manager in the enameling department

Two or three years later Messrs Archibald Kenrick & Sons of West Bromwich brought out a process upon the same principles but differing in some important details As a result of a long lawsuit between these two firms a compromise was arranged upon equal terms and to-day both these firms manufacture enameled goods upon the original principle but of course with many improvements in detail Of late years other processes of enameling differing in principle and composition are in considerable use in the enameling of baths and various miscellaneous and ornamental articles

The trade is being specialized and developed for different purposes but it still continues to be an adjunct or finishing process in several distinct trades This will in part explain why it is that trained scientific specialists do not appear to be generally employed in the works The position is unfortunate but not uncommon If any great scientific development is to take place it is imperative that the expert should be in close touch with manufacture in bulk for in no industry is there a wider gulf between successful laboratory experiments on a small scale and manufacture on a large scale which brings to light many important matters which are otherwise overlooked

The objects of industrial enameling on metals are 1 To provide a protective coat for the metal against corrosion either by the atmosphere or anything which may be brought into contact with the enameled article 2 To provide a smooth surface which may be easily kept clean 3 To provide a coat which will withstand a wider range of temperature than is possible with any varnish or Japan 4 For ornamental purposes 5 To provide an insulating covering for parts of electrical apparatus 6 To provide a hard surface for parts of textile machinery which will not only resist wear from the passage of the material but prevent discoloration from contact with the metal

The principal articles of commerce in enameled cast iron at the present time are 1 Culinary and household vessels which are required to resist the solvent or destructive action of water saline solutions weak vegetable acids weak alkaline solutions or fatty substances and may or may not be required to withstand moderate ranges of temperature 2 Baths lavatory basins etc, which more especially should resist the action of soap 3 Sanitary ware soil pipes etc which are used at normal atmospheric temperatures 4 Chemical vessels or apparatus which are specially designed to resist different agents 5 Ornamental articles some of which such as the outside shells of gas fires or other heating apparatus have to resist a considerable range of temperature 6 Miscellaneous articles such as reflectors insulated electric fittings and others

A vitreous enamel is usually a species of glass which is applied to the metal and fused thereon at a temperature ranging from a low red to a bright red heat but in very exceptional cases the enamel may not contain any silicate at all In general enamel consists of a mixture of several silicates or borosilicates with the addition of other substances for special purposes It is necessary for the enamel to have a comparatively low fusing point since with cast iron the highest permissible limit of temperature at which the enamel shall fuse must be low enough to obviate the collapse or deformation of the article by its own weight, which temperature will obviously vary somewhat with the shape and weight of the article It is however desirable to have the enamel with the highest permissible fusing point as the requisite qualities in the enamel are more easily attained than in the case of an enamel of lower fusing point

In the fabrication and application of an enamel for any required purpose the manufacturer is confronted with very many difficult problems one of which arises from the fact that a combination is attempted of two materials of very different physical properties On the one hand the metal is a good conductor of heat has a comparatively high coefficient of expansion for heat and is comparatively soft and resistant to shocks while on the other hand enamel is a bad conductor of heat is hard and brittle and unless care is taken has a lower coefficient of expansion

In view of the many conditions which have to be satisfied it must be recognized that as no enamel can fulfill every condition perfectly the best enamel for any particular purpose must be the most judicious compromise of conflicting conditions

If a chemist is required to report upon the merits of an enameled article he should especially examine and test it to see if it fulfills the conditions for which it was designed For instance in the case of an ordinary enameled saucepan which is manufactured for the purposes of cooking the testing to which it should be subjected should be somewhat as follows Continuous boiling with water for say fourteen days If it passes this test it should be subjected to continuous boiling successively for similar periods with weak vinegar dilute citric acid dilute solutions of sodium carbonate and sodium chloride If the enamel is attacked by these agents or by boiling water the polish or gloss of the surface will be replaced by a roughness more or less pronounced and easily seen when any deposits which may have been formed have been carefully cleaned off Milk should be allowed to stand in the cold in the vessel for a month since milk and especially sour milk will attack some enamels which resist the previous tests The enamel should be tested for hardness which should be sufficient to resist abrasion in ordinary cleansing operations The manufacturer's rough testing for hardness is usually performed by scratching with pieces of steel of varying degrees of hardness which are adopted as standards The saucepan should then be broken into pieces with a hammer and it should be noted whether the enamel adheres firmly everywhere to the fragments In passing it may be said that by variations in the way of hammering considerable differences in the result can be obtained The broken pieces should be examined to see if the coat of enamel is uniform and of reasonable thickness A good enamel for a saucepan should be somewhat thin Since enamel is a bad conductor of heat with a thick coat of enamel the temperature of metal when heated rises much more rapidly than that of the enamel This sets up strains which sooner or later do mischief A thick layer of enamel also considerably impedes the passage of heat to the contents of the vessel, so that by the time the fluids reach the boiling point the metal bottom of the vessel is at a considerably higher temperature If therefore the vessel be removed from the source of heat the moment the contents begin to boil the heat accumulated in the metal bottom of the vessel will cause the contents to continue boiling for some few seconds The tendency to boil over is a frequent cause of complaint when the enamel is too thick The other advantages of a thin enamel follow from a reduction of weight and do not specially concern the chemist

Another saucepan should be tested under reasonably rapid changes of temperature such as are likely to be met with in ordinary use Water should be raised to the boiling point in the vessel which should be then rapidly emptied and cold water substituted, repeating this a few times There should be no chipping or cracking A more severe test than this is scarcely reasonable for these articles

Enamel for cooking vessels should be tested by analysis for the absence of lead or other objectionable substances but with cast iron cooking vessels of British manufacture it is hardly necessary as no British maker appears to use any objectionable ingredients in enamels for cooking purposes

If the enamel appears to be composed of two distinct layers when the broken section is examined the red ink test should be applied to ascertain if the lower layer of enamel is porous or not If it is the red ink will penetrate and will be visible from the upper surface When the lower layer is porous any liquid readily penetrates through any slight defect in the upper layer and causes formation of rust which sooner or later detaches the enamel from the iron

The enamel for cooking vessels should be pure white in color the surface glossy perfectly smooth and free from defects Crazing or spider like cracks due generally to an error in the expansion coefficient in the enamel may be practically invisible at first but will reveal themselves if the enamel is rubbed with any dark finely divided powder Any test of a saucepan or cooking vessel with a strong acid or alkali is futile

In the same way with all other enameled articles the chemist's tests should have regard to the especial use for which the particular article is designed

It is found that comparatively small differences in composition produce marked differences in the physical properties of enamels and in their capacity to resist various agents

The results of the action of sulphuric acid upon enamel are sometimes curious In some experiments made to produce enamels to resist this acid one or two were found which would resist concentrated and also dilute (2½ per cent) acid for some weeks at least but at 50 per cent strength the acid quickly destroyed the vessel The greatest problem in producing large enameled vessels to resist such agents is not so much with the enamel itself as in the difficulty of getting a perfect coat of enamel all over the surface of the metal the most microscopic fault is fatal

It is a fact which should be more generally known that enamels have become highly specialized and different in their composition physical properties and methods of application In the enameling of cooking vessels in this country the industry is a perfectly healthy occupation for the operatives from the absence of any deleterious materials in the composition, or dust in the working operations On the other hand in some of the other uses of enamels there is need for proper precautions and Home Office rules which may be advisable in some cases are quite uncalled for in others The same manufacturers do not often produce more than one type of enamel

Cast iron as a base for enamels possesses one great advantage in that it forms a rigid support and the enamel has not to withstand the strains of bending In this respect it is much superior to sheet iron, but cast iron presents peculiar difficulties to the manufacturer in the application of the enamels The chemical constitution of cast iron is not a matter of very great importance, except that a high percentage of graphitic carbon is not desirable as the adhesion of the enamel is lessened It is also desirable that the plumbago or other facing used in molding the castings should be as small a quantity as possible for the same reason The most important question in the enameling of cast iron is whether the enamel is to be placed directly upon the natural skin of the casting, or upon a machined surface Upon the machined surface many varieties of enamel can be applied easily, which would fail entirely if placed upon the natural skin Enameling upon the natural skin presents special difficulties, and requires special treatment. If the skin of the casting is to be removed, it is most efficiently done either by a lathe or a planing machine or an emery grinder as neither acid pickle nor sand blast is found to be so effective for the purpose. This necessity in practice tends to limit the application of many enamels to castings of round elliptical or flat surfaces such as can be dealt with in lathes or in planing machines.

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* Read before the meeting of the Society of Chemical Industry held at Birmingham University, Birmingham England December 9th, 1909

When the skin of the casting is not removed efficiently and an unsuitable process of enameling is used it will be found that before the enamel has become hot enough to fuse completely it will in the language of the enameler commence to bleb. That is to say some action takes place which results in the evolution of a considerable volume of gas which causes the enamel to blister and when this happens it is then impossible to obtain a perfect coat by further heating. The blebbing appears to be due to a reaction between the metal and the enamel but may be due in part also to the liberation of the gases dissolved in the metal. Even when the skin of a casting has been removed efficiently and a suitable enamel has fused to a perfectly level coat a further unnecessary rise in the temperature will cause blebbing to occur and in general it may be said of any enamel upon cast iron that between the temperature at which the enamel will fuse quietly and the temperature at which blebbing will commence there is a somewhat narrow range and other things being equal the best enamel is that which has the widest range between these points because in practice the temperature owing to working conditions cannot be kept within very narrow limits and blebbing means waste and commercial loss.

From their experience in the enameling and tinning of castings on the natural skin manufacturers are of opinion that metallurgists have much to learn as to the constitution of the skin of castings.

In an attempt to throw some light upon the subject in its bearing on enameling and tinning I made some preliminary experiments to test the possibility of producing some considerable alteration in the constitution of the skin of castings. Various facing materials including steatite lime and magnesia dust were tried and castings were run in red hot loam molds faced with these various materials in an atmosphere of coal gas so as to exclude free and combined oxygen but so far the results have been entirely negative. There has been no observable difference in the appearance of the castings or in their behavior in enameling and tinning.

Preparation of an enamel. In compounding an enamel for any particular purpose the enameler usually makes no attempt to produce silicates of any definite chemical constitution but follows such empirical rules as his experience may have taught him to accomplish his objects and probably he is right. The preparation of an enamel must not only have regard to the physical properties required in the finished enameled article but must also conform to the qualities necessary in the enamel in the act of fusing upon the article some of which are: Temperature at which the enamel fuses, range between the fusing point and the temperature at which blebbing will take place, viscosity, surface tension.

The fusing point of an enamel is usually controlled by the proportion between the alkaline bases and the silica by the use of borax boric acid or in some cases by lead compounds but an undue proportion of alkaline bases or borax tends to produce softness and solubility of the enamel in aqueous solutions.

The difficulty as to 'blebbing' has been alluded to and must be lessened by experience and skill in producing the enamel.

As regards viscosity in the enamel in the fused state, a high degree of viscosity is especially desirable when it is necessary to prevent the fused enamel running down any vertical surfaces of the castings; on horizontal surfaces it is of course not so important. Silicate of alumina is one of the components which is frequently employed for this purpose but it has also a tendency to raise the melting point which must be readjusted. Barium silicate is sometimes used when it is desired to reduce viscosity but this has a tendency to lower the melting point of the enamel.

A high degree of surface tension is generally desirable in the enamel in the fused state as it is the play of this force at the moment of fusing which stretches the enamel to a level smooth surface. It is possible however, to have the surface tension too high. At the moment of fusing the force of adhesion between the enamel and the metallic surface or between the enamel and the under coat as the case may be, should be considerable, that is, the fused enamel should "wet" the surface. There must be a proper balance between the forces of adhesion and surface tension. If the adhesion is not sufficient the surface tension will cause the melted enamel to run up into isolated globules.

In the making of an enamel, the materials, in a fine state of division and well mixed, are fritted or melted in crucibles or reverberatory furnaces. The temperature of the furnace and the length of time in the furnace are important. Possibly the silica and the various bases arrange themselves differently at different temperatures; at all events the furnacing of the enamel materials may produce considerable differences in the physical properties of the enamel. The adjustment of the coefficient of expansion for heat does not usually cause much trouble as the enameler has his well known formula and method which generally turns out right. But when something goes wrong or when an enamel is required to comply with certain new conditions which may have been successfully met except that the expansion coefficient is too high or too low it becomes necessary to correct the expansion coefficient. There are several ways known to enamelers of doing this but it is the case with most of us that we cannot express even in approximate figures what will be the result of any given correction we may make. We do not even try to measure in figures the coefficient of expansion; all we know is that we must adjust it to that of cast iron viz. to 0.0000112 per degree Centigrade (0.00002016 per degree Fahrenheit) as measured between 0 and 100 C. (32 and 212 F.) and we do the adjusting by trial and error. Perhaps in the case of a saucepan it would be better practice to make the expansion coefficient of the enamel rather higher than that of cast iron since the enamel in contact with a fluid would rarely rise quite so high in temperature as the outside of the vessel while in contact with the source of heat. The subsequent cooling is a more gradual and equable process and not likely to set up sudden local strains.

Grinding the enamel.—Enamels are applied to the metals in various ways wet or dry but in all cases it is necessary to reduce the enamel to a ground or powdered state to permit of distribution in an even layer. The degree of fineness to which an enamel is ground or powdered is important. In the wet process the enamel must be fine enough to remain in suspension in water for some time but grinding too finely appears to affect the expansion coefficient for reasons which are not easy to see and the result is what is known as crazing i. e. very fine cracks in the enameled surface. Ideal grinding generally consists in obtaining all the particles of enamel of the same size but in some ways of applying the enamel it is an advantage to have a mixture of fine and relatively coarse particles. Grinding in the wet way is accomplished in mills lined with French burrs with runners of the same material or in horizontally rotating cylinders lined with hard porcelain and partially filled with glass balls or flint stones. With the mills the large surface of the runners moving uniformly over a large number of particles of enamel tends to reduce them all uniformly in size and is the best system where the enamel is required to be of any given degree of fineness except the extremely fine although this can be attained by prolonging the time of grinding. The cylinders on the other hand are best when the enamel is to be ground extremely fine. The actual surface contact between the glass balls or flints is so small that the pressure per unit of area is great and some of the enamel is at once reduced to extreme fineness while the remainder is comparatively coarse. For fine grinding the cylinders are not only better but rather quicker and the materials are not exposed to contamination from dirt.

For reducing enamel to powder in the dry way edge runners of granite on a granite base are used sometimes an ordinary French burr mill.

In all the foregoing methods every care is taken to prevent contamination by metallic particles or organic matter which gives rise to defects in the enamels. In some of the coarser forms of enameling where the specks and stains due to metallic particles do not matter edge runners of cast iron or ordinary stamps are used.

Application and fusing.—When the enamel is used in suspension in water as a cream it is ground finely with a small percentage of china clay magnesium sulphate or other agents to increase the specific gravity and viscosity of the cream so as to keep the enamel in suspension longer and to facilitate the operation of flowing the cream over the surface of the article to be enameled in a uniform layer of the desired thickness. After drying the enamel is ready for firing.

When the enamel is applied in the dry state it is not so finely powdered and is distributed with the aid of a sieve or in other ways over a surface coated with gum, or direct upon the red hot surface of the cast iron either the bare metal or coated with a first coat. In the latter case the metal carries enough heat to fuse the enamel immediately it falls upon the surface, if the operations are carried out quickly and the enamel has a low enough fusing point. It may or may not be necessary to return the article to the muffle to produce a perfectly fused surface. In some cases a combination of the wet and dry methods is used, and two or three coatings may be given of the same or different enamels by successive firings. When several coats are used it is nearly always an advantage for the lower coats to be less fusible than the upper. When different enamels are superimposed it is of course necessary that their coefficients of expansion agree and that they are otherwise a suitable combination.

In the firing of an enameled article in a muffle the enamels are partly protected against the furnace gases but not altogether. Some enamels will not stand the action of the gases for long without deteriorating and must be removed soon after complete fusing. With a casting of uniform thickness which rises in temperature equally all over the surface this presents no difficulty but in the case of a casting especially a large casting which has thin parts and thick heavy parts the heating is irregular and the enamel upon the thin places is liable to be fused and spoilt before the enamel on the thick parts is melted. Such work is difficult and requires great experience.

When an enameled surface is produced by two coats the lower of which is a borosilicate or other enamel of comparatively high fusing point and the upper a more fusible glaze some considerable advantages are gained one of which is that an enamel which could not be used direct upon the metal surface can be used as the upper coat. Another advantage is that when necessary the enamel may remain longer in the muffle without damage; this is important with irregular or heavy castings. This method however requires accurate adjustment of the enamels and special care in the operations otherwise the lower layer may remain porous so that liquids will rapidly penetrate by capillary action as soon as there is the slightest flaw in the upper surface. The lower layer must at least soften sufficiently to form a solid mass or the upper layer must penetrate the lower layer and fill all porosity.

White enamels.—Colored enamels are produced much in the same ways that are adopted with glass or pottery and scarcely require comment except where the enamel is a more or less opaque or translucent white. There are several ways in use for producing the effect of a white surface. (1) By mixing with a transparent enamel some opaque white substance which does not enter into combination with the enamel but remains as a mechanical mixture. Oxide of tin is an example. A specially pure and finely divided oxide is prepared for enameling and is introduced at the latest possible stage so that the mixture of enamel and tin is heated as little as possible otherwise the oxide of tin will enter into combination with the silica with a partial or total loss of opacity. In the application of the wet method the oxide of tin is often added to the enamel within the mill and the two are merely ground together. Bone ash is probably another example. (2) Cryolite or other fluorine compounds with some enamels will produce a translucent white. Apparently the effect in these cases is due to the production of minute crystals having a different refractive index to the rest of the enamel. Overheating causes a loss of opacity which partially returns on cooling. (3) A white color may be produced by coating a transparent or opalescent enamel upon a white ground layer of a borosilicate or other mass of a comparatively high fusing point. The lower layer does not fuse completely but softens sufficiently to adhere to the surface of the metal and supplies an opaque white ground while the upper layer of enamel furnishes the smooth and glossy surface. (4) The effect of a white color can also be given by the production of excessively fine air bells in a transparent enamel. In this case considerable viscosity in the enamel is necessary otherwise the air bells coalesce with a loss of opacity.

Pinholes a common trouble of enamelers are solutions of continuity of the surface of the enamels in the shape of small round holes. They are due to several causes. (1) Presence of fine particles of organic matter which are allowed to get into the enamel for the upper coat. Splinters of wood ground up with the enamel are a common source of trouble. These minute particles of organic matter become decomposed with the heat of the muffle and form small bells of gas which either remain as such or burst and form holes in the enamel which frequently will not close up. (2) Microscopic fissures or holes in the casting the air from which expands by heat and forms air bells in the enamel. (3) Blacks that is slag or scum in the skin of the castings which produce bells of gas by reaction with the enamel. (4) Imperfections in the first coat of enamel which expose the metal to the attack of the upper coat of enamel. (5) Particles of foreign matter or spots due to imperfect preparation in the first coat of enamel where the force of adhesion is less than the rest of the surface; these result in spots which the upper layer of enamel will not cover.

Principles in application of enamel. There are at least four well defined different principles in the application of enamels to cast iron.

1. That embodied in Clark's patent viz. an under

coat of considerable thickness with a relatively high fusing point this is applied in the wet way dried and fired and an upper coat of enamel of a lower fusing point added

2 A very thin special under coat is applied in the wet way dried and burnt right into the surface of the iron There is then scarcely any visible coat but the surface of the iron is affected so that the propensity to blister is retarded and an ordinary fusible upper coat can be added

3 A moderately fusible enamel is applied in the wet way direct upon the surface of the iron dried and fused

4 One or more coats of very fusible enamel are applied as a dry powder direct upon the red hot surface of the metal

Methods 1 2 and 4 can be used either upon the natural skin of the casting or the machined surface Method 3 as a rule can only be applied upon a machined surface although with a few enamels it is possible to coat upon the natural skin It is not a matter of indifference which way any given enamel may be applied

It has been recommended to submit the casting to the Bower Barff process as a preliminary to enameling In my own experience I have not found any special advantage in this while the extra cost has been a serious commercial handicap

To satisfy many of the conditions laid down in this paper either singly or together is not so difficult, but to satisfy all of them at the same time is difficult, and sometimes impossible It is to be hoped that enamelers will abandon their habit of attacking problems single handed and will combine among themselves and with trained chemists seek to place upon a different footing an industry which if it is destined to remain a minor one is at least of absorbing interest

In conclusion I have to express my acknowledgments to Sir William Kenrick Sir George Kenrick and Mr C F Clark for information in this paper— Journal of the Society of Chemical Industry

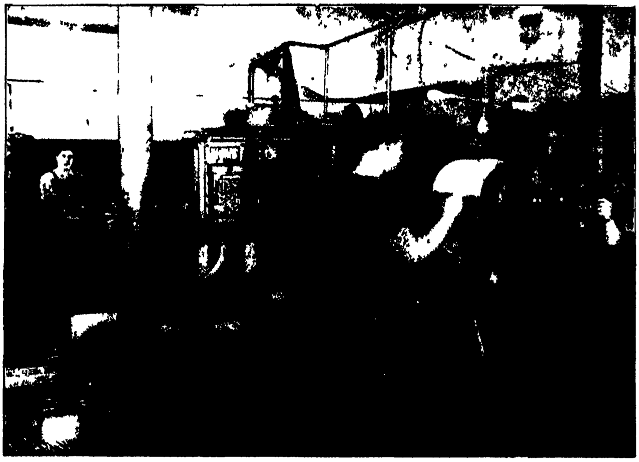
MODERN STEREOTYPY.—II.*

THE MECHANICS OF THE NEWSPAPER.

BY HENRY A. WISE WOOD.

Continued from Supplement No 1791, Page 282

The printing machines of the present day are composed of many printing couples the products of which are gathered collected and delivered by one or more folding machines A printing couple is composed of the plate bearing printing cylinder and its co-operating blanket covered pressure cylinder It is by the latter that the web is borne to receive the impress of the type A four couple press of four pages in width has usually two folding machines or folders as they are called the normal speed of the modern folder being 24 000 newspapers an hour such a press may be run at the hourly rate of 48 000 four six or eight paged papers Or if its two webs are split and the parts from one side are transferred over and combined with those of the other and all are run into one folder then as but one folder is being used the number of pages of each newspaper produced may be doubled but a production of but half the number of newspapers will be possible Thus 10 12 14 or 16 paged papers may be produced by a four couple press which is technically known as a Quadruple or Quad machine at the rate of 24 000 copies A machine having six printing-couples known as Sextuple or Six by using two folders is capable of all the combinations of a Quad but by using an additional web is able to make 10 and 12 paged papers at the rate of 48 000 and 18 20- and 24 paged papers at the rate of 24 000 an hour An Octuple having eight printing couples and using four webs is capable of turning out products of 14 and 16 pages at the greater rate and of 26 28 30 and 32 pages at the lesser rate of speed Octuple machines usually have four folding mechanisms and thus are able to attain a rate of output upon products having eight pages or less of 96 000 copies There are also machines in use having twelve printing couples while still others known as Double Octuples have sixteen With collecting mechanisms at work in each case a product of double the number of pages may be obtained but at half the full rate of production Competition has recently driven the manufacturers of newspresses to rate their machines higher in speed than that mentioned but as no essential change has been made in the mechanisms employed little real gain in the actual hourly average of product has resulted It should be understood that the rates of output cited are merely indicated In practice the speed of two hundred turns of a press-cylinder per minute which, if continued for the hour should produce with one folder 24 000 copies actually results in but from 16 000 to 18 000 more or less A press must be stopped when each of its web-rolls expires and resupplied with paper which greatly reduces the number of minutes run in the hour and paper breakage a frequent source of trouble and delay still further reduces its output



THE AUTOPLATE CASTS FOUR 50-POUND STEREOTYPES A MINUTE

Saves $500 a week in printing expenses and enables pages to be held open longer

In the foregoing description of the development of the modern newspress I have not thought it necessary to refer to the transitory forms of machines which have occasionally appeared but have deemed it sufficient for the purpose of this lecture to trace the main stream of progress along which the machine of to-day has come

From the foregoing it will appear that the newspaper now depends upon the co-operation of three important mechanical departments The composing room the stereotyping foundry and the press-room Having shown how the newspaper is "set" and how it is printed I shall now take up the indispensable link which connects the two This brings me to the main subject—Stereotypy, Old and New In order to illustrate the great importance of the art of stereotypy I shall set before you the images of two newspaper offices the one without the other having the advantages which stereotypy confers In the first the type clamped in curved frames called *turtles*, *may be* used upon but one press The turtles having been secured in place and the machine started in the course of an hour's time 10 000 copies or at most 20 000 are produced and distributed How little such a puny output could satisfy the needs of the present day will appear when it is known that the circulation of many evening papers is now about three hundred thousand copies and that there are some that closely approach to half a million My second image need be nothing more than that suggested by the statement that in a modern metropolitan newspaper office will often be found combined in one form or another from forty to sixty complete perfecting printing méchanisms, and that within twenty minutes after the arrival at its stereotpying foundry of the last page of type all of its presses fully supplied with printing plates will be turning off newspapers at the speeds I have mentioned The importance of the art of Stereotypy is plain when it is realized that by means of it a plant containing sixty press-units is now possible and that such a plant is capable of producing the equivalent of from seven to ten hundred thousand eight paged newspapers an hour Thus it will be seen how vastly it has multiplied the productiveness and therefore the usefulness of one of man's greatest mechanical discoveries—type

In the year 1890 I first became interested in the art of Stereotypy, which was then being practised exclusively by manual means But a few devices, power driven and hand-controlled, had been provided to facilitate its work. One was used to remove the riser or sprue of the freshly cast plate, while another, when the plate had been dropped into it by hand, served to smooth out the plate's inner or seating surface. In but one other function was the work of the hand assisted by power. The moist papier maché sheet, or "flong" as it is called, after it had been laid upon the type-page and covered with a felt pad, was molded to the face of the latter by an iron roller beneath which it was drawn upon a bed propelled by power. Excepting these, all of the operations of stereotyping required the direct employment of the thought, the eyes and the hands of workmen.

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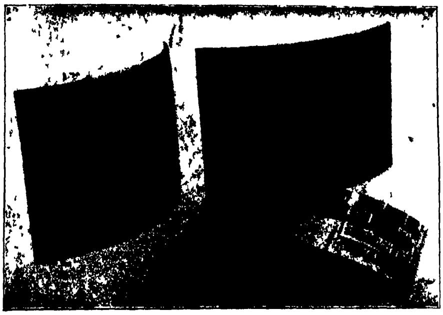
* Read before the Franklin Institute



CURVED STEREOTYPE PLATES READY FOR THE PRESS.

The process of stereotyping then in vogue may briefly be described as follows. To prepare the flong two blotter-like sheets of paper were pasted together, and upon one side of these four sheets of close-fibered rice straw tissue were pasted. The paste used, its composition then a trade secret, was of flour, a clay and a germicide, the latter to prevent fermentation. Flongs enough were made for the next day's requirements, and these were allowed to season in a moist place. As each type-page reached the foundry a flong was laid upon it tissue side down, and upon the flong a closely woven stout felt blanket. Page, flong and blanket were then run beneath an iron roller, the operation of molding thus being performed. Before the advent of the molding press the flong was beaten into the face of the type-page by long-handled brushes, a slow process which the roller superseded. From the molding press the type-page with its molded flong (now become a matrix) still clinging to its face was carried to a steam-heated iron table, where the molding blanket having been exchanged for several layers of dry soft blanketing, an unheated iron plate or "platen" was screwed down upon it. Heat thus applied to the type drove all moisture from the matrix into the blankets, and usually in from four to six minutes the matrix, or "mat" as it is usually called, became dry and was ready to be cast from. In the eighteen years that have since elapsed this process of molding and drying has undergone but a slight improvement. Better paper and paste have increased the durability of the matrix, and an improvement in technic has made it more sensitive to the delicate "effects" of modern illustrations, but if a slight reduction of the time consumed in its making be excepted, the process of matrix making has scored no substantial gain. Of progress in the making of plates, however, a different story is to be told.

When stereotyping was first adapted to newspaper printing, certain implements were necessary in order that suitable printing plates might be made. The employment of the rotary press required that the plates be curved. It was also requisite that they be of uniform thickness, and that their curved ends be beveled so that they might be held by clamps to the cylinders of the press. These conditions necessitated the use of a curved casting-mold, or "box" as it is called. In this the paper matrix was bent and clamped. The mold was then closed, a hinged semi-cylindrical core acting as cover, and into it a ladleful of molten stereotype metal was poured by two men who had fetched it from a nearby caldron. After the appropriate time for solidification had passed the mold was opened and the casting, with its clinging paper matrix, removed. Then the delicate operation of stripping the matrix from the face of the cast was cautiously performed, and the matrix was returned to the mold and repositioned for another cast. Meanwhile the first cast was placed upon the cylinder of a "cutting-off" device where, after having been nicely positioned and securely clamped, it was turned beneath a power-driven rotary saw and its riser, or rough upper end removed. The saw of this apparatus was so shaped that it left the curved edge of the cast beveled. The cast was then turned and its other end passed beneath the same saw in order to insure to it likewise a satisfactory clamping surface. The cast was then inverted and dropped face down into the hollow of a "shaving-out" device, in which a rotating straight-edged knife served to smooth or plane its inner surface and to give it an accurate thickness. In order to reduce the surface thus needing to be planed it was customary to construct the core about which the cast was to be made with narrow circumferential grooves set an inch or so apart. In the casting operation these grooves were reproduced upon the inner surface of the cast as ribs or finishing strips, and furnished a surface which, when planed, was ample to support the cast plate under the pressure of printing. After it had been shaved the cast was next set face up upon a fixed cylinder or "horse," where two men with hand plane and chisel removed from its edges all superfluous metal which might otherwise take ink and print. This was called finishing. From the finishing horse the cast plate was next carried to a trough and cooled, and thence to the press room, where it was dried and clamped to the cylinder of a press. All of these operations, save only the propulsion of the cutting-off saw and shaving knife, were performed by hand. And for each plate made every function, from the precise positioning of the matrix to the drying of the finished plate, had to be repeated.

ROUTING CURVED STEREOTYPE PLATES.

The casting mold was a heavy and clumsy piece of apparatus which consisted of back and core, a bottom ring beneath which the lower matrix edge had to be clamped, two side bars which had then to be laid upon the straight sides of the matrix to hold it in position, and clamps for finally locking the halves of the mold together before it should be stood on end to be filled. Two men were required to insert and position the matrix and put the mold together, and likewise to take it apart after its contents had cooled and remove the cast and matrix. Another man was required to cut off the riser, a fourth to shave the plate, a fifth and a sixth to finish it, and still another man to dip it. The rapidity with which such a crew could work with a single casting mold was at the rate of a plate in every minute and a half. Thus in order to produce ten plates from a matrix, or enough to supply five quadruple presses with the plates required to enable them to print a single page, from fifteen to twenty minutes were consumed. If in an office having five such presses an eight-paged paper was to be run, eighty plates had to be made, the casting and finishing of which consumed nearly two hours if but one casting box were used, or half the time if two, as was the custom, were employed.

As the circulations and bulk of newspapers increased, presses and pages were added, until at last the one hundred odd paged Sunday issue produced in a press room having no less than sixty unit printing mechanisms, each requiring perhaps sixteen printing plates, ceased to be a rarity. As its pages and presses grew in number so also did the stereotyping plant of a newspaper in the number of its men and pieces of apparatus. And at last the pressure of plate making became intolerable in the offices of the large metropolitan journals. Nevertheless, up to the close of the last decade of the last century the process of stereotyping was carried on in the primitive manner described and entailed the performance of hard manual labor under injurious conditions of temperature and haste.

The accompanying illustrations of the hand-worked process of plate making exhibit the principal operations to which I have referred, and are representative of the most advanced state of the art when in 1900 the Autoplate machine was first set to work in the office of the New York Herald. Perhaps the most concise summary anywhere to be found of the nature of the change effected by the introduction of machine stereotypy, is in the following extract from the New York Herald itself: "The third department of newspaper mechanics—stereotyping—has remained almost at its starting point, one of the few arts still in the realm of hand labor. It is twenty years since the last improvement was made, and now in the last year of the century the art is raised to the mechanical level of its sister arts by Mr. Wood's invention, which does automatically with few men's hands to aid it what formerly required many hands and fourfold the expenditure of time. Thus in the closing year of the nineteenth century the last act of the mechanizing of the printing trade has been accomplished. First came the rotary press in 1860, then the linotype in 1888, and now the autoplate in 1900."

(To be continued.)

THE BATTLESHIP OF THE FUTURE.*

WHAT WILL IT BE?

BY REAR ADMIRAL R. H. S. BACON, C.V.O., D.S.O., ASSOCIATE.

The battleship is solely a gun platform. The gun is at the present moment the main weapon in deciding naval actions; therefore progress in battleship design has been continuously in the direction of increased offensive gun power and defensive armor protection against gun power. The development of gun power has followed closely upon the improvements in the manufacture of steel. The cast gun with spherical shot was superseded by coil guns, rifling and pointed projectiles. The restriction of the chamber pressure which could be allowed in the early days involved low muzzle velocities and short range. Improvements in propellants and strength and more reliable material for construction have increased the length of range and led to longer guns and higher pressures. The result has been that the accuracy of the gun to-day at 12,000 yards is considerably greater than the accuracy of the gun of thirty years ago at 2,000 yards. At the present moment the development of the gun shows no signs of abating, and there is every reason to believe that if required the power of the gun can within the next few years be considerably increased. The first important questions in design are: Is such an increase necessary? What advantages would it confer, and what disadvantages would it entail? To consider these we must examine the second feature of a battleship, namely its defensive armor.

The distinctive feature of the battleship over the cruiser is that in the battleship speed is sacrificed for defensive armor protection. The armor is disposed with its greatest thickness in the belt, gun positions and conning-tower, so as to protect those portions which are vital so far as maneuvering and gun fire are concerned.

There is no doubt that the gun of the present day can with armor-piercing projectiles at a range of about 6,000 yards penetrate any armor which can be practically mounted in a ship, and guns can be built which can penetrate this armor at ranges outside which it would be practically impossible to bring a fleet action to a decisive conclusion. Therefore if anything approaching modern design of battleships is to be adhered to, it is perfectly hopeless to think of attempting to supply armor which would be impenetrable to any guns which may be constructed in the reasonable future. If such a thing were attempted we would have to return to the shape and speed of the old Inflexible. Moreover, if such a ship were constructed and impenetrable armor provided, the racking entailed by successive hits of heavy projectiles would cause such a general leakage as to leave the ship little better off than if the armor had been penetrated.

This race between gun and armor which has been going on for over half a century is being decided for the moment in favor of the gun, nor is there any indication of there being a chance of improving the armor and strengthening general construction so as to render ships reasonably immune from armor-piercing projectiles. So far therefore as regards mere perforation of armor with armor-piercing projectiles, there seems to be no immediate necessity for increasing the power of the gun.

The armor-piercing projectile, however, is not the most efficient shell for effecting general damage on a ship, and penetration of armor is not the sole object of gun fire. The chief damage will probably be done by heavy bursting charges. The heavier the bursting charge the greater the damage inflicted by each individual hit. There can be no choice so far as damage is concerned between a large burster and a small one, and therefore from this point of view the larger the gun and the larger the projectile the better. Again, accuracy in the performance of a gun can be best obtained by development of the gun and projectile in reasonable proportions. With power-worked mountings the rate of fire need not be reduced as guns increase in size, and therefore the desirability of rapid hitting and effect of the hits when obtained both point to steady increase in the size of the guns. The sole limitation as regards progress in the size of a gun carried is the increase in displacement necessary.

If the gun is to be increased in size on the same displacement one of these three things must happen: (1) The number of guns must be reduced, or (2) the armor protection must be reduced, or (3) the speed must be reduced.

The extra weight required for the guns must be obtained from one of these three sources. We therefore find that while accuracy and efficiency point to increase in size of gun, this increase must be obtained at a sacrifice.

First as regards displacement. It has often been said that our ships are too large, and as regards this there are two distinct issues: (1) Finance and expediency. (2) Efficiency and utility.

The chief argument against size is the enormous cost of each ship, and therefore the large loss in case of sinking. Another argument is that our harbors are already too small, our docks require enlarging, and the ships become too large to handle in fleets. As regards the first of these arguments, the whole crux of the question seems to lie in the consideration as to whether a large ship or a small ship is more likely to be lost from the attack of a torpedo. Constructionally there seems no doubt that the larger the ship the more likely she is to survive the blow of a torpedo. Surviving, however, is not the sole point. Damage by a torpedo will temporarily incapacitate a ship however large she may be, and therefore a bigger money value of fighting appliance will be temporarily incapacitated by a single torpedo attack in the case of the large ship than in the case of the smaller; but the smaller ship may sink and the loss become permanent. This question therefore resolves itself into one of time of repair. Provided therefore the number of ships are kept constant, although their size is increased, no danger from the torpedo accrues to the country by building larger ships. The matter from this point of view becomes one of the national purse, and whether while retaining *pro rata* numbers we can afford to build bigger ships.

There are, however, many who uphold the view that they prefer a larger amount of smaller ships to a less number of large ships, and that the money devoted to naval construction would be better spent upon numbers than upon size. The features of this contention require careful consideration. It must be assumed that an equal sum of money is spent in either case. The smaller-sized ships involve carrying fewer guns or a mixed armament of heavy and lighter guns, both of which are adverse factors to hitting at long ranges.

The most modern type of battleship at present constructed is represented by the "Dreadnought" class and the improved succeeding vessels. Of course it is well known that the chief features of the "Dreadnought" are the installation of an all-heavy caliber armament of the heaviest nature, accompanied by increase in speed. Whatever arguments have been raised against this type have been proved by subsequent experience to have little weight with European navies, since all have to a large extent adopted the principal features of the "Dreadnought." It was only to be expected that the sudden transition from the "Lord Nelson"—or really, so far as general knowledge in the navy and the country was concerned, the "King Edward" type—to the "Dreadnought" was certain to evoke criticism and comment. The directness that characterized the Admiralty administration of that period swept aside all compromise and designed a ship with no guns of any sort except the 12-inch and 12-pounder, the latter being then considered the most suitable for dealing with destroyers.

The main reasons underlying the abolition of the secondary armament were first, that these guns tended to reduce the accuracy of hitting of the heavier guns, and secondly, that the weight and therefore the extra tonnage that the installation demanded could be better devoted to other purposes. The contention as regards accuracy of hitting has been well borne out by subsequent experience. Without entering into any technical reasons—and the argument is very highly technical—one point can be easily appreciated, and that is, that when the undivided attention of those directing the fire of the guns is concentrated on one type of gun only, it is far easier to correct the fire of the guns efficiently than to correct the vagaries of three calibers of guns of varying rapidity of fire and of varying external ballistics, all of which are firing at the same object.

It must be appreciated that a 6-inch gun at long range is of no use at all against thick armor, and against the lighter armor and superstructures the small burster of the light weight of the shell militates against much real damage being done to the ship even by a large number of such projectiles. It is held that a hail of such projectiles is liable to damage communications, etc. This might possibly have some weight provided that the hail really exists in practice, or that if it exists the hail hits the ship. As a matter of fact, when gun fire is handled so as to attempt to obtain hits, rapidity of fire falls very much below the possible rapidity of fire of the gun, and the actual rapidity of fire may easily fall to a quarter or less of the possible rapidity. In fact, when the fire of a quick-loading gun at long range is intermixed with other guns, rapidity of fire falls off very considerably, since it is now appreciated that rapidity of fire unaccompanied by rapidity of hitting is a futile waste of ammunition. It is generally considered that 6-inch fire at ordinary battle range may be discounted when accompanied by a 12-inch gun fire.

There are, however, a considerable number of people who hold the view that battles will not always be fought at long range, and therefore in thick weather the smaller guns may more nearly approach their theoretical value. It is perfectly possible that battles may be fought at moderate ranges, but it must not be forgotten that the accuracy and rate of fire of the heavier guns is also increased *pro rata* at such ranges, whereas the actual effect of the bursters and fragments of the projectiles at these ranges is not greater than at the longer ones, and that the damage occasioned by small projectiles is in no way comparable to those of the heavier type of guns.

If it were possible to install guns of this nature in a ship without either restricting the fire of the heavier guns or of unnecessarily increasing her displacement, and if it were thoroughly understood that they were only there to be used in thick weather, there might be some advantage in installing them. The difficulty, however, of such an installation is very great. If placed below the tier of heavy guns their position comes very close to the water; if placed on a level they are bound to reduce the arc of fire of the heavier guns, and if placed above them they involve considerable top weight, since, wherever they are put, if they are to be of value in a fleet or single ship action they must be protected by adequate armor. The futility of installing any guns for use in an action unless they are adequately protected against gun fire is apparent. If the fighting power of the ship with a mixed armament is to be kept the same as that of a ship with a single-caliber armament, the small gun must be in addition to the large ones. The question of the installation of such guns is therefore purely one of whether the designers consider the extra tonnage to be worth the advantage that may accrue. Up to the present, those responsible for the construction of our ships appear to take the view that the advantage is not worth the extra displacement.

The question of mounting an intermediate type such as the 9.2-inch or 10-inch, as well as the heaviest type, is slightly different, since these guns have a projectile more capable of inflicting damage at long range, but when the disadvantage of a dual armament is considered, in conjunction with the comparatively small amount of weight saved and the small increase in rate of fire obtained practically by mounting such guns instead of an additional number of heavy guns, there is not much doubt that in the future the single heavy armament will carry the day.

There is one other aspect as regards the mounting of 6-inch guns, and that is from the point of view of those guns being used merely for anti-torpedo boat guns. This is advocated by those who look on the 6-inch gun as a better anti-torpedo boat gun than the 4-inch. This is purely a matter of opinion, and there is a greater excuse for mounting 6-inch guns for this purpose than for use in an action, since it does not involve the necessity of providing them with armor protection. Their use would then be largely confined to defense against torpedo craft before the day of a general action arrived, and for this purpose they require no armor protection. It is not likely that after a general action with the present day heavy ordnance these guns, whether protected or not, would survive to be of much practical value.

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* Read at the spring meeting of the fifty-first session of the Institution of Naval Architects, March 16th, 1910 (condensed).

One point, however, must not be forgotten, and that is that the possibility of mounting 6-inch guns in future ships sets a low limit on the thickness of armor belt, since it would obviously be foolish to reduce this to an amount which would allow these small guns to effect penetration at battle ranges, and therefore to lay the ship open to vital attack by small guns.

In building the small ship, speed, size of gun, and power of each hit are sacrificed. Moreover, the length of the line of battle is considerably increased. The fewer the guns mounted in each ship, the larger the number of ships that will be required for an equal number of guns; therefore the larger number of intervals between the ships and an equivalent increase in the length of the fighting line. This is further, a very important consideration when the question of the use of the torpedo during an action comes to be considered.

As regards the size of our harbors, we have still plenty of places where we can berth ships 100 per cent larger than the Dreadnought, and without real inconvenience. Size is by no means the only inconvenience in handling a ship in a close harbor, and from practical experience I can vouch that the Dreadnought was from every point of view more easily handled in a close harbor than the Irresistible, whose tonnage was [illegible]0 per cent less. It must also be remembered that increase of the size of ship in comparison with the size of harbor may be met by a development of methods and of auxiliaries such as tugs. As regards depth of water, although certain harbors may be less convenient than others, we have still plenty that can be used even if greatly increased draft becomes a necessity.

As regards maneuvering with a fleet, no greater libel was ever published than the statement that the Dreadnought could not be maneuvered satisfactorily with the fleet, and any naval officer of experience who is not an automaton would find no difficulty in handling vessels of [illegible]0 per cent greater tonnage, even when in company with the lighter class of battleships. The fact that the Dido class were about one-third the tonnage of the Bulwark did not prevent their safe handling when in company.

The use of the torpedo during a fleet action can no longer be neglected. The improvements of late years in this weapon have been considerable. It has been very much the fashion up to date to disregard the possible developments of this weapon. There is no doubt that of late years in America, on the Continent, and also at Messrs. Whitehead's, there have been introduced improvements into the torpedo which have totally altered the character and use of that weapon. It is not improbable that these improvements are merely in their infancy, and that before many years has elapsed we may find ourselves confronted with a weapon of considerably greater powers. If the range of the torpedo can be brought up to 6 000 yards it has great possibilities in an action. There is no doubt that it is far easier to hit one of twelve ships with a torpedo than to hit a single ship aimed at, and therefore the longer the line of ships and the greater their numbers, the more vulnerable they will be to attack by destroyers at long range in an action. This is an additional argument in favor of increasing the size of individual ships rather than the number of ships in the line.

As regards retention of the present thickness of armor protection, this is a matter which may before long undergo considerable modifications, and the armor problem of the future appears to resolve itself into the answer to the following question: Supposing the guns of the enemy can with certainty pierce armor protection at reasonable fighting range, what is the most economical thickness of armor to adopt? Very many considerations are involved in the answer to this question, such as the position and thickness of horizontal armor, but considering the enormous sacrifice in weight now made to carry thick armor protection, it is a matter that before long may undergo bold and radical revision.

We now come to the third possibility of saving weight, and that is reduction in speed. Probably there was no point among the improvements introduced into the Dreadnought that was more violently attacked than the increase in speed from 1[illegible] to [illegible]1 knots, and the attempts made to prove that such an increase was of no value were legion. It is probable that this increase will in time be looked upon as one of the most valuable features of this design. It has been impossible for anyone to argue that from a strategical point of view such an increase in speed was not of value, but from a tactical point of view this increase was bitterly attacked. This attack arose from not taking a sufficiently broad view of the possibilities of the future.

The speed of a ship when she is built remains practically constant all her life. Judging from past experience, it is improbable that the designed speed of a ship will ever be subsequently increased. Fifteen years ahead is a long time to look forward to, but the careful student of naval progress is forced to take into account the possibilities of all naval weapons. The improvements in the torpedo must in time introduce a class of tactics more analogous to single ship than fleet actions. It is in such a class of tactics that speed will become a valuable factor, and it is highly probable that the speed of battleships will increase up to that of the cruisers.

It is therefore probable that to get the maximum efficiency out of the gun and yet not to decrease the numbers mounted in a ship, increase in tonnage and reduction of belt armor of battleships will be features in future construction, and that for other reasons the value of speed will be enhanced.

It does not seem possible that the size of gun will be limited unless all nations agree to do so, and such an agreement is highly impracticable. It would be a foolish policy on the part of any nation to install smaller guns than those carried in the ships of rival powers. Again it would be [illegible] to provide guns [illegible] than the design permits. The number of guns carried in a ship cannot well be reduced below that of the Dreadnought, otherwise the difficulty of hitting at long range with such an armament will be considerably increased.

To sum up, all the considerations of offense and defense point to increase in size of battleships as modern gun construction advances. But since the modern battleship no longer holds the supreme position which in the old days made the battleship the sole ultimate arbiter of sea power, it is improbable that as the torpedo improves battleships unable to defend themselves against any form of torpedo craft will be built merely to fight battleships. The functions of the large cruiser will therefore be assumed by the battleship; high speed will become more and more necessary, and armor protection will be less [illegible] than at present. The link between the ocean-going destroyer and the battleship will become closer, and we may reasonably expect that the huge monsters of the future will always be accompanied by torpedo craft of high sea-going speed as defensive and offensive satellites.

The battleship as now known will probably develop from a single ship into a battle unit consisting of a large armored cruiser with attendant torpedo craft. Line of battle as we now know it will be radically modified, and the fleet action of the future will in course of time develop into an aggregation of duels between opposing battle units. The tactics of such units open up a vista of most exhilarating speculation, and will afford to the naval officer of the future a scope for his tactical skill never dreamed of by us.

THEORIES OF IMPACT

In a recent number of Habilitationsschrift C. Ramsauer reviews the elastic and mechanical theories of impact. He states that previous experimental work shows that the course of an impact is now exactly that required by the elastic solid theory. His work deals with the determination of impact velocity and duration of impact employing a new optical method which allows the course of the impact to be followed independently of all theory. The impinging bodies used were of cylindrical form, and the impact at one end was communicated by means of a lever to a movable mirror at the other end, thus causing the deflection of a spot of light on a rotating drum. The paper is divided into two parts, in each of which one of the theories is tested in the light of experiment. The fundamental condition of the elastic theory, that the impact pressure instantaneously becomes uniform over the section, can be fully realized in practice by the use of spirals and of rubber cylinders with ivory ends. Cylinders of this kind, of the same section and material, fulfill all the demands of the elastic theory as regards the course of the impact, duration of impact and final velocity. Peculiarities noted during impact are due to the dependence of wave velocity on the amplitude of compression, on imperfect elasticity and on elastic after-effect. For small compressions the wave velocity in rubber reaches a limiting value which lies far above that found by statical methods, from this value the modulus of elasticity can be calculated free from the disturbance due to elastic after-effect. An ideal mechanical impact may be produced by the use of spring heads on solid steel cylinders. This ideal case, besides conforming to the law of conservation of energy, must also be such that the time of impact of equally long cylinders varies as the square root of the length or mass, the time of impact must also be independent of the velocity. The course of the mechanical impact is fundamentally of an elastic nature. If the ratio of the elastic modulus of the rigid portion to the modulus of the head falls from infinity to smaller values, the properties of the impact lie between the two theories; this is the case with the impact of two solid cylinders, which proceeds as though the transference of energy took place by means of a more easily compressible intervening layer.

ARTIFICIAL FABRICS

The term "artificial fabrics" is here used to denote not fabrics woven of artificial fibers, but fabrics produced directly, without weaving, from various solutions of cellulose. Several processes for the production of artificial fabrics have already been patented. The processes form two classes. In one class the solution or paste of cellulose is divided mechanically into filaments which, at the moment of solidification or immediately thereafter, are so assembled as to form an interlacing network of various types. To this class belong the processes of Millar, Drouinat and Chaplet. A better method, however, consists in subjecting the solution of cellulose to a sort of fibrous crystallization, which is brought about either by the action of a coagulating substance upon the moving cellulose solution or by the influence of the carbon dioxide of the air. To this class belong the processes of Cross, Bevan and Beltzer. In the methods of the second class the fibers are not arranged in a geometrical pattern, but form a sort of felt in which they cross in every direction.

None of these processes, however, has yet been carried out in practice. Still they should not be dismissed as useless. The manufacture of artificial silk was first suggested in the middle of the eighteenth century by Réaumur, yet this manufacture did not assume practical form until 1889, and several years were then consumed in overcoming difficulties of all sorts. It is probable that the manufacture of artificial fabrics, which, by the way, was also suggested by Réaumur, will undergo a similar evolution, and that the present period of experiment will soon be followed by one of industrial development.—Cosmos.

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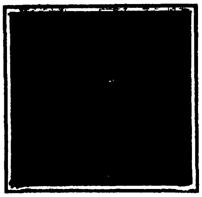
The concept of the ether, according to N. Campbell in the Philosophical Magazine, was developed in order to provide a vehicle for the adulatory energy of light, and is now regarded as the vehicle of all forms of electromagnetic energy. It would therefore appear natural to identify points in the ether by the amounts of energy located in them. But consider the case of two or more electrically charged bodies moving with different uniform velocities relatively to the observer. The velocity of the ether relatively to the observer would then be different according as one or other of the charged bodies was considered, and would be in each case the same as the velocity of the corresponding charged body relative to the observer. This leads directly to the principle of relativity, which has been proved to form an adequate basis for electromagnetic theory. If it be not permitted so to identify a point in the ether, no other means of identification can be substituted. The first requisite for the application to the ether of the definition of velocity which is implied in all statements concerning the velocities of material bodies cannot therefore be fulfilled until some other definition of velocity is put forward as applicable to the ether; all propositions about velocity of or relative to the ether are meaningless. This objection would be removed if it were possible to define the velocity of a charged body relative to the ether as its Absolute Velocity. But Absolute Velocity is meaningless unless the fundamental propositions of dynamics are assumed to be true. It is therefore logically impossible to assert at the same time (1) that axes fixed in the ether are axes of which the Absolute Velocity is nil, and (2) that the Mass of a body increases with its Velocity relative to those axes. It is therefore contended that the concept of the ether should be abandoned, and electromagnetic theory embodied in equations based on the principle of relativity.

Elimination of all level crossings is being gradually effected by the Pennsylvania Railway. Since January 1st, 1900, according to information sent out by the Pennsylvania Company, 6[illegible]3 level crossings have been removed on the lines of this company east of Pittsburg and Erie. This includes only work completed up to September 1st, 1909, and does not include the ten crossings to be eliminated by the projected change of the line through Bristol, Pa., on the New York division. On the lines between New York and Washington, Philadelphia and Pittsburg, 2[illegible]6 public level crossings and 12[illegible] private level crossings have been removed in the past ten years, leaving only 774 public crossings scattered over 574 miles of road. On the division between Philadelphia and Washington alone 106 level crossings have been eliminated; between Jersey City and Philadelphia seventy-eight crossings have been removed, and on the Pittsburg division forty-six crossings have been taken out.

ARCHÆOLOGY IN NORTH AFRICA.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

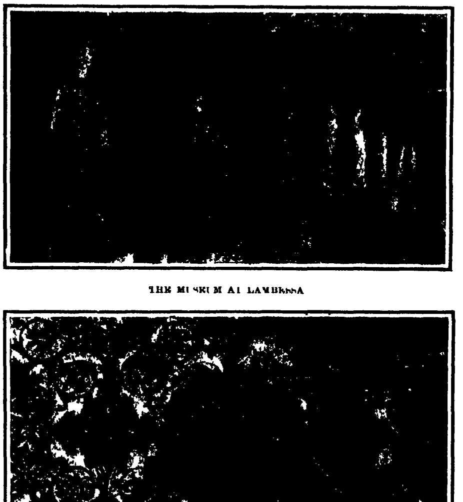


THE North African region lying in Algeria and Tunisia offers an almost unlimited field for archæological research and on some of the sites of the ancient cities this is being actively carried on at present. On the site of Carthage alone there are thousands of tombs which after remaining buried at depths of twenty or thirty feet underground for two thousand years are now yielding sarcophagi and funerary objects which throw light upon a hitherto unknown civilization. An immense number of objects is now collected in the museum from the excavations made by the Rev. P. Delattre one of the leading French archæologists who has been the chief moving spirit in this great enterprise. The objects of the Punic period or the epoch before the Roman domination are of course the most valuable but the specimens relating to Roman and Christian archæology are also of much interest. Most of the ruins of temples basilicas and like structures on the site of Carthage relate to this latter period.

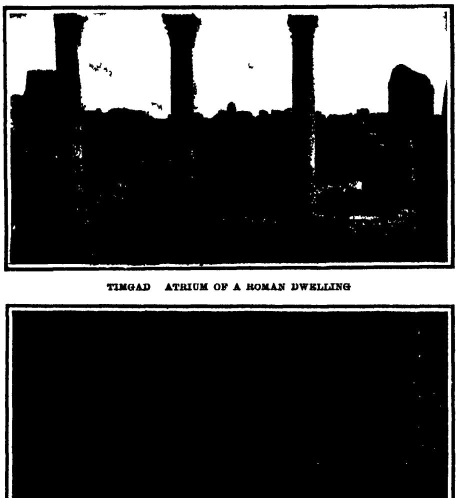
Of the more ancient epoch is the great necropolis of the priests and priestesses of Carthage and the exploration of the tomb has been carried on within a recent period owing to a subsidy furnished by the Paris Academy. We are able to mention some of the leading features of this work from information which has been kindly furnished to us by Rev. P. Delattre. The tombs lie very deep underground and are reached by a vertical shaft as is usual in the case of the Punic tombs. The shafts were sunk through the loose ground until they reached solid rock in order to cut the funerary chamber in this material. In these chambers there are usually found sarcophagi of limestone which contain calcined and broken bones together with coins and amulets or in other cases with funerary objects such as vases phials and mirrors. Sometimes the burial chamber lies as deep as [illegible]0 feet below the ground and in one case which we may cite as an example the entry of the chamber leading from the vertical shaft is three feet high and but two feet wide. At six feet above the entry there was a still larger chamber with two burial pits and this in turn communicated by a break in the wall with a third chamber which contained three burial places. The first mentioned chamber measures seven feet in length and but four feet wide and about the same in height and it is difficult to see how the Carthaginians could let down such a large sarcophagus to this depth and then store it in such a small space. Beside the sarcophagus were placed a funerary vase and two cups (paters) and also a lamp of Greek form with five Punic coins representing Persephone and also the horse's head which is typical of Carthage. In another burial chamber was a sarcophagus bearing the inscription Tomb of Gratmelquat priestess of the goddess referring no doubt to the goddess Tanit as a statuette of this divinity was in fact found among the funerary objects as also nine small vases with handles five black vases ten two-handled lamps of the Punic type and seven of Greek form also eighteen ointment boxes of terra cotta fifty bronze coins a small mirror several pieces in ivory including a distaff and other objects which will give an idea of the great variety of specimens found in these tombs. Among other specimens from the tombs is a Carthaginian seal representing a warrior in the act of combat. Gold objects are often found in these tombs such as a gold ring with the sign of Tanit gold appliqué ornaments of star shape, ear rings of different forms seal rings bearing sacred symbols or portraits of the wearer and the like.

The sarcophagi which have been taken from the various tombs of Carthage are now preserved in the museum and there are already a great number in the collection. Among these the most noteworthy are the sarcophagi in white marble, one of which we represent in the illustration. The main body of the sarcophagus was painted with ornamental bordering and various designs while the stone cover bears a life-size figure in relief. Traces of painting can also be seen upon the sculptured figures and especially in the eyes which thus have a lifelike appearance. The present sarcophagus bears a figure of a male personage in high relief having the face bearded and he is clothed in what appears to be a ceremonial costume. From the upraised position of the right hand and also from the sacred vessel which he bears in the left hand as well as from the general appearance of the figure the person is no doubt a member of the priesthood. The sarcophagus dates from the Punic or pre-Roman period of Carthage and various remains were found within it such as a gold ring with a massive seal. The seal bears the image of a head in profile which appears to be the likeness of the same person who is sculptured on the cover. There were also found a round box containing twenty-four Punic coins a stone amulet which appears to have been worn upon the breast and also three gold rings. Not long since the present sarcophagus as well as one which is similar to it and bears a sculptured female figure were transferred to the Louvre museum, where they are to remain definitely.

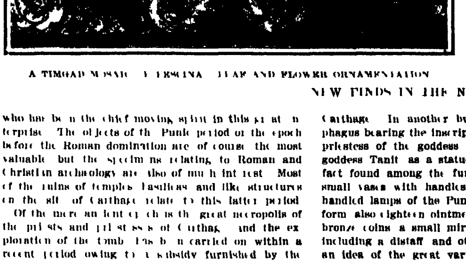
Excavation work has been carried out actively within the last few years on the site of Timgad and a great part of the ruins of the ancient Roman city of Thamugadi is now uncovered. The appearance of the ruins, which cover a vast area justifies the comparison which is sometimes made with Pompeii this being due to the fact that the remains of houses temples and other buildings are found in a comparatively good state of preservation as will be noted from some of the most recent views which we present here. One of these represents the atrium of a Roman dwelling, and three of the columns as well as part of the stone paving are well preserved. In the rear will be noticed a large stone basin of semi-circular shape, which has scarcely suffered. Another view represents the remains of a private dwelling, and it is of interest from the large bath-pool which is formed of upright flat stone slabs set on edge and having a range of marble columns



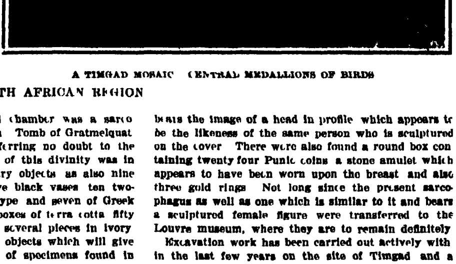
THE MUSEUM AT LAMBESSA



TIMGAD ATRIUM OF A ROMAN DWELLING



A TIMGAD MOSAIC [illegible] LEAF AND FLOWER ORNAMENTATION



A TIMGAD MOSAIC CENTRAL MEDALLIONS OF BIRDS

NEW FINDS IN THE NORTH AFRICAN REGION

surrounding it. The flooring of the bath pool was laid in an ornamental mosaic, which we also reproduce. It is one of the many different mosaics which are to be seen at Timgad, and has a handsome decorative design composed of leaf and flower ornamentation. Still more attractive is the second mosaic, which will be noticed, and it has two central medallions bearing figures of birds.

Marble statues have also been found in various parts of the ruins, and we illustrate one of the most recent, this being the statue of Abundance. It is a handsomely draped figure, and is executed somewhat in the Greek style. The present statue was found in the Forum, and it has been set up on the outside of the museum, together with a number of marble statues, sarcophagi, columns and the like, which are assembled from all parts of the site. The museum, the roof of which is set around with capitals of columns, now contains a great number of specimens, and these are continually increasing owing to the constant finds which are being made. Among the principal buildings the capitol is especially worthy of mention, and two of the gigantic columns are still standing. The great size of these columns will be judged from the appearance of one of the capitals which will be observed here. As there is not enough room in the small quarters of the museum, a great number of objects have been collected in what may be called an open-air museum. Prominent among these will be seen the stone flour mills, which, as is usual in the Roman mills, have square openings in the sides for use in inserting the beams so as to drive the mill. Such mills have been found at Pompeii and other places.

An interesting site in the North African region is the Roman camp of Lambessa, which lies in the region of Timgad. Since our previous account there has been a number of objects brought to light on this spot, although the greater part of the site still lies underground. The camp of Lambessa may be taken as unique of its kind, and nowhere do we find a Roman one of such importance, in spite of the destruction which it underwent through the ravages of time. Should it ever come to be exposed methodically, it will no doubt give the solution of a great number of questions which we cannot answer as yet concerning Roman military work. The camp was a rectangular inclosure and well fortified, containing a gate on each of the four sides. The Pretorian gate was flanked by two semicircular towers, and had a double vaulted passage somewhat recalling the fortifications of the Middle Ages, but the walls of the camp were not surrounded by a moat. Inside one of the bastions at an angle of the camp were found stone projectiles about the size of an egg, which served for the catapults and like engines. Near the camp extended the town of Lambessa, which was an outgrowth from the former. Most of it, however, remains to be excavated. One of the most recent finds is the handsome bronze statue of Ganymede, which is executed in the Roman style and represents a child carrying the eagle of Jupiter. Enameled eyes were inserted in the spaces which now appear empty. We also show a number of marble statues found at Lambessa since the excavations were first made. A very handsome mosaic, with a subject representing Bacchus, is also among the noteworthy objects.

TIMGAD: ARCHITECTURAL ORNAMENTS OF THE CAPITOL

BRONZE STATUETTE OF GANYMEDE AT LAMBESSA: A CHILD CARRYING THE EAGLE OF JUPITER

THE STONE COVER OF A WHITE MARBLE SARCOPHAGUS OF THE PUNIC OR THE ROMAN PERIOD OF CARTHAGE. LIFE SIZE

NEW FINDS IN THE NORTH AFRICAN REGION

* * *

FORMATION OF OZONE BY THE ACTION OF ULTRA-VIOLET RAYS

In the year 1909 Lenard discovered that ultra-violet rays ozonize the surrounding air. The phenomenon can now be very easily observed, for the characteristic odor of ozone is strongly marked in the vicinity of the mercury vapor lamps which are now often used for illumination. A short time ago Bordier and Nogier attempted to detect, by chemical methods, the ozone produced by ultra-violet rays, but although they used a very sensitive method, they obtained a negative result. Hence they announced that no ozone is produced by the ultraviolet rays of the mercury vapor lamp, and explained the observed odor as a purely subjective phenomenon.

Van Aubel has recently endeavored to detect the presence of ozone in air traversed by ultra-violet rays, and has obtained decisive positive results. In one of his experiments olive oil, in which ozone is readily soluble, was allowed to remain for about two hours in the outer glass globe of a quartz mercury vapor lamp, where it was exposed to intense ultra-violet radiation. The oil was entirely bleached. A mixture of starch paste and potassium iodide solution turned blue when mixed with this oil, showing that the oil contained ozone in solution. This reaction was not produced by olive oil which had not been exposed to ultra-violet rays.

The same reaction was shown still more strongly by petroleum, under the same conditions. Another striking proof of the formation of ozone is described as follows: A piece of filter paper saturated with potassium iodide and starch was laid in a shallow porcelain dish. Partly covering the strip of paper and about one-twentieth inch above it, was placed a plate of quartz, about 1-6 inch thick. The dish was placed on the bottom of the glass globe of the mercury vapor lamp, so that the filter paper was exposed to the ultra-violet rays. These rays penetrated the quartz plate, but the ozonized air which was contained in the globe could not readily flow under the quartz plate, although it could reach without difficulty the parts of the paper which were not covered by the plate. After the exposure had continued about two minutes the part of the filter paper which was not covered by the plate assumed a dark blue tint, while the other part of the paper remained nearly white. This result proves that the coloration is produced by the ozone in the air, and not by any direct action of the ultra-violet rays.

CHEMISTRY AND ARCHÆOLOGY

Chemistry and archæology are two provinces which apparently, it may be said, have no common point of contact; the former does purely practical work with the aid of the crucibles, funnels and retorts of the laboratory, and the latter embraces a field which the historian and the philologist in the ancient languages is accustomed to work with the help of his theories in the quiet of his study. Occasionally, however, the latter is confronted with the fact that it can use also certain of the latest incontrovertible data of natural science as a means for deeper recognition. So it happened, says Dr. Rammstedt in a comprehensive report published in a recent number of Die Naturwissenschaftliche Wochenschrift, that the Paris chemist Prof. Le Chatelier strove successfully to ascertain the temperature at which Greek pottery was burned, which was approximately 9[illegible]0 degrees Celsius, the same stupendous heat that is used at the present day to burn earthenware and products of clay, and that he was the first to be able to prove that in regard to porcelain the old Egyptians were not, as was formerly assumed, dependent on remote China for that product, but themselves manufactured such a ware that, when its chemical composition is considered, was precisely like the ware that is produced still to-day in Sèvres. Very seldom indeed will chemistry fail, says Prof. Neumann of Darmstadt, to decide whether or not a work of art, a figure of bronze or a metal vessel for instance, is genuine, that is, to attribute the work to a correct date, for the chemical composition of the alloys changes very much in the course of time, and the certain partial transformation which such a work suffers under the influence of the air also depends on its constituents. The examination of a lead pipe [illegible]000 years old that was found in the island of Broni before the entrance to the harbor of Pola has shown, says Fleber, that like the present pipes or conduits used in modern canal construction it was made of two tubes, one drawn through the other, which were soldered together, and thus the conduit were capable of resisting a great pressure.

Further enlightenment is afforded by the examination made in conformity to natural science by Prof. Dragendorf of Frankfurt a. M. of traces of the victuals once used as rations by the soldiers of ancient Rome. The Roman camp near Haltern, in which many persons believe they recognize the fortress castle Aliso erected by Drusus in the year 11 B. C., was probably a great emporium for all those things which the Roman General Staff had to send to the rear of the Rhine and the troops in its service invading Germania. The pottery found there, which was for the conservation of wine, oil and similar beverages and foods, must be attributed [illegible] however mostly to the South, while the large amphoras which were used for the transportation of grain were made already at that time in Castra Vetera, the old Xanten on the Lower Rhine. As the examination of the piles of refuse near the Saalburg has shown, the soldiers' rations consisted not only of bread, for the preparation of which the grain was ground in small hand mills, but also of fish, snails, mussels and oysters, as well as many kinds of fruit, especially peaches. Of the great earthen vessels used for the transportation of commodities, the few specimens extant are marked with many inscriptions regarding their former contents. These marks indicate the strict care with which the Roman General Staff did its official work, and from them may be seen that already at that time an extensive trade in wine was in normal progress along the Rhine, to which numerous districts contributed their vintages. Of metal vessels the common man of that day knew very little if anything; he ate from earthen, mostly unglazed plates and cooked in pots of the same ware. As may be seen, natural science and a chemistry of victuals, which seem to have come 1,900 years too late, are nevertheless able to establish still to-day much that is of luminous interest, and to afford praiseworthy enlightenment in a province of knowledge which the philologist in ancient languages and the historian has hitherto considered as belonging exclusively to himself.

WHERE TO FIND THE STARS.

A LINK BETWEEN THE STAR MAPS AND THE SKY.

BY F. R. RUSSELL.

It is very difficult to recognize stars by studying the star maps and then seeking in the sky the stars marked on the maps But if we come to know our way in the heavens, so as to be able to find readily the Celestial Equator, Celestial Poles Ecliptic and our Zenith, and notice the position of a star relative to these points and lines it is not at all difficult to refer to the same places on a map and find the name of the star desired and the constellation to which it belongs

To know our way thus in the heavens we must always remember the exact point on the earth from which we are looking The earth is divided into 360 degrees north and south, and 360 degrees east and west, and the vault above us is divided into corresponding degrees The equator divides the earth into two equal parts and the line due north and south connecting the poles is at right angles with the equator

As the earth is divided into 360 degrees north and south, the heavens which inclose it are likewise divided into 360 degrees We can see half that amount, 180 degrees, at one time The other half envelops the half of the earth below our feet and is, consequently, invisible to us We see 90 degrees from the horizon on our right hand to our zenith and 90 degrees from the horizon on our left to our zenith, our zenith being the exact point overhead where we may be standing at any given time

If we are placed on any spot between pole and equator we see these latter landmarks at different angles in the heavens At Greenwich, which has the latitude 51½ N., the parallel in the dome above us is 51½ N at our zenith. We see 90 degrees between the celestial equator and the celestial north pole, and the remaining 90 degrees is made up by the difference between the north pole and our horizon on the one side, and between the equator and our horizon on the other

The celestial equator, seen from latitude 51½ N., is rather less than halfway up between the southern horizon and the zenith, and the celestial north pole is rather more than half way up from the northern horizon. That is, we see from our northern horizon to the north pole in the heavens 51½ degrees, from the pole star to our zenith 38½ degrees, making 90 degrees from horizon to zenith on the northern side On the other hand, if we face south instead of facing north, we see from the southern horizon to the celestial equator 38½ degrees, and from the equator to our zenith 51½ degrees That is, 90 degrees from the southern horizon to our zenith and 90 degrees from the northern horizon to our zenith—180 in all

Only the stars traveling on that portion of the heavens are visible to us from our latitude

Our horizon line on the south is 38½ S., and our horizon line on the north is 38½ N

In Oporto, Portugal, latitude 42 N., the horizon lines are 48 N and 48 S In Wellington, New Zealand, latitude 42 S., the exact reverse holds good, the South Pole taking the place of North Pole, and the southern horizon that of the northern horizon. In the northern hemisphere the southern horizon is so many degrees below the celestial equator, according to our latitude, and the northern horizon is so many degrees above the celestial equator which is not visible to us from that side

From atmospheric conditions heavenly bodies look larger, and the space they travel through seems greater, when near the horizon, and a planet or star at 45 degrees above the horizon will look more than half way up to the zenith, which it, in fact, is

In the heavens degrees count from the equator to the poles as on the earth the equator being 0 and each pole 90, but instead of calling those degrees parallels of latitude they are called declensions, though they correspond with our terrestrial latitudes. Standing on latitude N 20 (as in Mexico) the corresponding line overhead is also 20 N but a heavenly body on that line is said to "have the declension 20 N"

To find our way east and west in the heavens is more difficult than north and south, because the earth's motion has to be taken into account The earth has many and complicated movements on its journey through space but the only two that much affect us in watching the stars are the diurnal one as it turns on its axis every 24 hours from west to east, and the annual one as it journeys on its path round the sun every year, also from west to east

A position on the earth east and west is determined by meridian lines of longitude Any line drawn straight from pole to pole, cutting the equator at right angles, is a meridian line.

The line through Greenwich is chosen to count from by all English-speaking countries, and is called the First Meridian, the earth being divided into 360 degrees, 180 east, and 180 west.

Most Continental towns count from the meridian of Paris, instead of that of Greenwich There are also meridian lines in the vault above us, but instead of being called longitudes they are called right ascensions

A line in the heavens which is directly over a certain place at 12 noon will no longer be over that place at 1 o'clock, because the earth will have shifted itself eastward a twenty fourth part of its diurnal journey in that time, or 15 degrees If the sun is over the meridian of Greenwich at 12 o'clock, as the earth revolves eastward at the rate of 15 degrees an hour, the sun will be directly over the meridian of all places 15 degrees west of Greenwich an hour afterward, when it is one hour after noon at Greenwich.

When the sun is directly over the meridian of any place it is mid day or noon to that place As the sun rises toward the east and sets toward the west, when it crosses the line due north and south, or the meridian, it has made half its journey, and is, consequently, at its highest point in the heavens It is the same with the stars

As the earth revolves on its axis every 24 hours the whole dome of stars appear to turn round over our heads in that time That is, if we were standing on one of the poles, with the corresponding pole in the heavens directly in our zenith, we would see all the stars make a circuit round the point overhead, as though we were standing still in the center beneath a revolving dome The stars near the pole make a very small circuit, while those farther off move in a larger circle, the circles growing larger and larger until they reach the horizon, when, being on the celestial equator, they circle the whole round of the heavens

On the contrary, if we were standing on the equator we should see all the stars rise and set, some traveling right overhead, rising due east and setting due west, others whose circuits are smaller ones nearer to the poles rise to the north or south of east and set to the north or south of west, their path making an arc in the sky, but never reaching the zenith

At 20 N lat. (in Mexico, for instance) almost all the stars disappear beneath the horizon, only a very few whose declensions are very near the North Pole being visible in their entire circuit.

This diurnal motion of the stars round the pole makes it easy to find the pole in the sky In the northern hemisphere there is a star, the Pole Star, within 2 degrees of the celestial north pole, and any night the surrounding constellations can be seen circling round this point.

As the journey round the pole takes 24 hours, the difference in their position every 3 hours is very apparent, being an eighth of the whole distance If we look at the Great Bear any night at 9 o'clock, and again at midnight, it is easy to recognize this motion of the stars The stars nearer the pole have a small circuit, and those beyond the Great Bear have a larger and larger one, according to their distance, and, consequently, sooner or later, dip below the horizon In the southern heavens there is no star like the Pole Star in the north, but the South Pole is easily recognized as the pivot round which the constellations turn. The Southern Cross, with its pointers, the two bright stars in the "Centaur" and "Triangulum Australis," nearer still to the pivot of the southern heavens, can be watched circling round the southern pole night by night, at all seasons, in the same way as the Great Bear circles round the North Pole.

The apparent path of the sun is called the "Ecliptic." There are certain constellations like a broad band, through which this ecliptic runs, and which make an easy mark in the heavens and help us much in finding our way in the sky. These constellations are called the zodiacal constellations, and are each marked by a sign of the zodiac peculiar to itself. They are visible at night only at certain seasons of the year, depending on the position of the earth as it travels round the sun among the stars.

The stars whose circuits are small and near the poles are visible every night of the year in their respective hemispheres, but those that circle round the equatorial regions are visible at certain seasons only; at least, early in the night. This is easily understood if we take a ball of wool and a lamp as an example. As we move the ball round the lamp in the center of the room, the ball represents the earth, the lamp the sun, and the walls of the room the star-sphere The path in which the ball is moved represents our orbit, or path round the sun, and it will be seen that as it travels round the lamp (or sun) is sometimes between us and one side of the room and sometimes between us and the other side When the sun is between us and one side of the star sphere, that side of the star-sphere is concealed from our view by reason of the light of the sun, while the other side of the star-sphere is visible to that half of the earth which is turned from the sun and to which it is night Each half of the earth is alternately every 12 hours in light facing the sun with the invisible heavens beyond, or in shade facing the visible heavens without the sun

As we travel round, the sun appears in a line with every constellation on the ecliptic in succession. The lamp is, as it were, projected against, first one object, then another, on the walls in a line behind it Our journey round the sun takes a year, and twelve constellations have been noted at nearly equal distances, through which the sun appears to travel, and are called zodiacal constellations When the sun is projected against, or in a direct line with, one of these it is said to be "in" such-and such a constellation. At that time this constellation is invisible at night, because it has set with the sun, having risen with the sun in the morning and traveled with the sun across the sky during the day All the stars in the equatorial regions have their seasons in the same way

We see 180 degrees or half the heavens at a time, thus six of these zodiacal constellations are visible at once The earth moves round the sun from west to east, taking 12 months for the journey, and being in one of these constellations each month. Consequently, if one constellation has set with the sun in the west, the next eastward to it will be the distance of a twelfth part of the ecliptic above the western horizon, and in the next month will be setting with the sun in its turn.

As the earth in a year completes its journey through the dome of stars, traveling from west to east, we are always moving on this journey as well as turning on our axis.

If we only turned on our axis we would find any given star in the same position at the same hour, night after night As it is, the earth, having moved eastward on its annual journey to the amount of one degree, any given star appears farther west at the same hour, each night, to that amount One degree represents four minutes in time, so that a star being one degree westward each night is seen four minutes earlier above the eastern horizon, or, to express it otherwise, rises four minutes earlier every night—roughly speaking, half an hour a week and two hours a month. Thus, if we look for a certain star at a certain spot in the heavens at 10 o'clock to-night, we must look for the same star at the same spot at 8 o'clock a month hence Or, otherwise, if we seek for a star on our meridian at 8 o'clock to-night, we must look for the same star 30 degrees west of the meridian at 8 o'clock a month hence.

The position east and west of each star in the heavens is mapped out in the same way as its position north and south. The 360 degrees north and south are, as we know, counted *from the equator to the* poles and are called "Declensions."

The degrees east and west are counted from the point in the heavens where the sun is found at the March Equinox, that is, the first point in "Aries," one of the zodiacal constellations, and are called "right ascensions." They are counted either in degrees 360, or in hours 24, each hour representing 15 degrees Wherever we may be on the earth we see the sun cross our meridian at 12 o'clock; this tells us our position in regard to the sun, but it does not tell us the earth's real (and the sun's apparent) place among the stars at any given date. This is calculated by "right ascensions." Each star has its position in regard to the 1st point in Aries mapped out so many degrees (or hours) East. When the sun appears in a line with such-and-such a star of such-and-such a "right ascension" we know our place in the heavens at the time, and how far we have traveled on our annual journey from Aries back to Aries again. Each star has its "right ascension" and this right ascension comes to our meridian once in every 24 hours as we turn on our axis. The "right ascension" and declension of every star is given in most star atlases and almanacs, and the hour of each star's passing the meridian of Greenwich at different seasons is generally added

By knowing the part of the ecliptic where the sun is at a given date and the right ascension of the constellation with which it is on a line it is easy to compare the right ascension of any given star and to see if it has passed the meridian before the sun when we cannot look for it early in the night or whether it will pass the meridian soon after the sun when we may look for it to be visible in the heavens as soon as the sun has set

Seeing Aries just above the horizon setting in the west we may look for Libra soon to rise in the east as if the sun is now in Aries it will be in Libra six months hence and Libra will then be setting at sunset and has consequently half the heavens to traverse in the six months Between Aries and Libra come Taurus Gemini Cancer Leo and Virgo visible in succession across the ecliptic

If we refer to our almanac and find the sign in which the sun is at the date we seek we may look for the zodiacal constellations of the six months following in the sky after sunset the remaining six constellations being below the horizon

The signs of the Zodiac are written as follows

♈ (Aries), ♉ (Taurus) ♊ (Gemini) ♋ (Cancer) ♌ (Leo), ♍ (Virgo) ♎ (Libra) ♏ (Scorpio) ♐ (Sagittarius), ♑ (Capricornus), ♒ (Aquaris) ♓ (Pisces)

The first six are north and the remaining six south of the equator

Most of the zodiacal constellations are conspicuous by one (or more) bright star

Aries possesses one star of the 2nd and two of the 3rd and 4th magnitude making a curved line

Taurus is easily recognized by the brilliant 1st magnitude star Aldebaran which is accompanied by a V shaped cluster of bright stars forming a figure not unlike a bull's head Aldebaran being at one point The constellation of the Pleiades a cluster of six bright stars is in the bull's shoulder

The Gemini consist of two brilliant 2nd magnitude stars (sometimes counted as 1st magnitude) of nearly the same size and of many smaller stars forming the continuation of the Twins as far south as Orion

Cancer is a miserable little group hardly discernible forming a sort of square and is best found by being on the direct path of the sun between Gemini and Leo There is no star above the 4th magnitude in it but this constellation is often quoted as the sun is in the sign of Cancer when it reaches its highest point north 23½ degrees Cancer contains a remarkable nebula not visible to the naked eye

Leo is shaped like a sickle with a beautiful 1st magnitude star Regulus in the handle

Virgo stretches a long way across the heavens its most southerly point ending in Spica a 1st magnitude star 10 degrees south of the equator representing the ear of corn which the Virgin holds the sun being in Virgo during the harvest month in the north

Libra the balance is entered by the sun at the September Equinox It is not very unlike the Twins having two stars in a straight line of an equal size but the stars are not so large as Castor and Pollux and are not so close together This constellation is quite eclipsed by the one following it

Scorpio the scorpion which not only boasts of Antares an exquisite reddish star as its heart but has two bright 2nd magnitude stars at its southern extremity and a cluster of bright 3rd magnitude stars at the northern close to Libra

Sagittarius the Archer comes next also south of the equator with four bright stars (of 2nd and 3rd magnitude) making a kind of square narrowing toward the north and with four brightish smaller stars farther north still

Capricornus the Goat contains no star beyond the 3rd magnitude but a pair of two which comes close together has somewhat the resemblance of horns

Aquarius, the Water carrier is also far from striking but can be found with no great difficulty by a cluster in it something like an incomplete W

Pisces the twelfth zodiacal constellation is made up of a group shaped like a palm leaf also a number of tiny lines of small stars seen only well on clear nights, continued as far south as Fomalhaut in Pisces Australis a brilliant 1st magnitude star shining as far as 30 S

When we are acquainted with the zodiacal constellations and with the circumpolar ones it is not difficult to master the remaining principal groups in the heavens

The chief constellations round the North Pole are First the Great Bear, with its seven bright stars two of which, called the Pointers point direct to the pole, the Pole Star itself being in the tail of the Little Bear At the opposite side of the Polar Star is Cassiopeia, forming a clear W, the W representing the chair on which she is sitting The Dragon joins the two Bears. A little farther south the brilliant stars Vega in Lyra, and Capella in Auriga, are nearly equi distant from the pole, and are seen all the year round from Greenwich. If one is high toward the zenith the other will be low on the horizon according to the season and hour of night

In the southern hemisphere there is no star exactly at the pole but the Southern Cross circles round it containing two stars of the 1st magnitude and one of the 2nd while the two brilliant pointers Alpha and Beta, of the Centaur make it easy to find At one side of the Cross even nearer the South Pole is the Southern Triangle (Triangulum Australis) consisting of three stars equal in size easily recognized At the other side is the magnificent constellation of the Ship Argo Navis containing Canopus one of the brightest stars in the heavens as well as Eta Argus which varies in brilliancy reaching the 1st magnitude at its brightest

Any constellation in the same position east and west with one of the familiar zodiacal ones (having that is the same right ascension) will be visible when that zodiacal constellation is up in the heavens

For instance when the Gemini and Taurus are to be seen traveling across the sky we may look for Orion (the Hunter) to the south with his companions Canis Major and Canis Minor—the Greater and Lesser Dog

This splendid group contains four 1st magnitude stars Sirius in Canis Major being the brightest in the entire heavens then come Procyon in Canis Minor and Rigel and Betelgeuse in Orion This group being south of the equator the greater part is visible for a longer time in the southern hemisphere than in the northern

Again when Sagittarius the Archer has risen above the horizon we may look for Aquila the Eagle containing Altair a star of 1st magnitude and lose to it the dear little cluster the Dolphin Also three 4th magnitude stars in a tiny line between Aquila the Eagle and Cygnus the Swan which represents Sagitta the Arrow presumably shot by the Archer toward these birds

Lyra is close to Cygnus and somewhat southwest of these constellations is the lovely little constellation of Corona like a diadem in shape formed by six stars one very bright

The Milky Way a belt of innumerable tiny stars appearing like a luminous track across the heavens makes another clear mark for us to follow in the sky In the southern heavens there are gaps of darkness in this luminous track known as the Coal Sacks and the Southern Cross is close to one of these gaps

There are only about twenty 1st magnitude stars

1 Achernar in Eridanus
2 Aldebaran in Taurus
3 Antares in Scorpio
4 Altair in Aquila
5 Arcturus in Bootes
6 Alpha Centauri
7 Alpha Crucis
8 Beta Crucis
9 Beta Centauri
10 Betelgeuse in Orion
11 Canopus in Argo
12 Capella in Auriga
13 Eta (variable) in Argo
14 Fomalhaut in Pisces Australis
15 Procyon in Canis Minor
16 Regulus in Leo
17 Rigel in Orion
18 Sirius in Canis Major
19 Spica in Virgo
20 Vega in Lyra

When we have mastered the chief constellation and are acquainted with all the 1st magnitude stars if we see a bright star where no star should be we may conclude that it is a planet

Most almanacs give the dates when planets are visible and in which constellation always a zodiacal one—they are to be found There are eight planets not counting the small ones between Mars and Jupiter These eight are in the following order as regards the sun—each has its accompanying character which is marked in the almanacs

Mercury ☿ Venus ♀ the Earth, ⊕, Mars ♂ Jupiter ♃ Saturn ♄, Uranus ♅ and Neptune, ♆

Of these Uranus and Neptune are not visible to the naked eye so with the earth also deducted there are only five planets which we can see

Two of these Mercury and Venus are only visible as morning and evening stars and Mercury being so near the sun is rarely to be seen at all

When we see a planet rise in the east travel across the sky at night and set in the west keeping the motion of the stars that we are acquainted with on the zodiacal line even without the help of the almanac, we know that it must be either Jupiter Mars or Saturn and we can make a good guess by its appearance which of the three it is Jupiter is much the brightest Mars shines with a red glow and Saturn has a light so much duller than the other planets that (together with its peculiar motion among the stars) it was thought by the ancients to have an inauspicious influence

The planets travel slowly, but quite perceptibly, among the constellations changing their places relative to the fixed stars These fixed stars as we have seen each appears to travel across the sky night after night but keep their relative positions in regard to each other so as to form recognizable constellations Whereas the planets are to be seen sometimes in one constellation and sometimes in another Thence they originally received their name of Planets Wanderers

Besides the sun moon planets and fixed stars there are comets and meteorites which visit our field of view but their movements are for the most part beyond an amateur's calculation

There are also star clusters and nebula but these are hardly visible to the naked eye Stars are of various colors white green orange and red

These when they are doubled have often blue green or violet companions Double stars are not seen by the naked eye

The principal 1st magnitude stars are white among these come Sirius Vega Rigel Altair Regulus and Fomalhaut Our sun is a yellow star also Capella Arcturus Aldebaran and Pollux The principal orange star is Antares in Scorpio also Mira the variable star in Cetus There are no red stars of great importance The white ones are in a state of glowing heat The yellow are intensely hot but less so than the white orange stars are cooling down and the red are cooler still

Some stars vary in brilliancy with different periods for their times of change The most renowned variable stars are Algol in Perseus having a period of 2 days 20 hours and 48 minutes Mira in Cetus called Marvellous on account of its change from brilliant orange red to insignificance At its brightest it is just visible to the naked eye Its period is 1 month Betelgeuse in Orion varies from the 1st to the 6th magnitude and Eta Argus varies from the 1st to the 7th At its brightest it rivals Sirius which is the brightest in the heavens

Several stars are called double stars that is have a companion revolving with them Sirius has one so much smaller than himself that it may only be a satellite Among other remarkable doubled stars are A pair in Lyra yellow and green a pair in Orion orange and blue Rigel and companion white and blue a pair in Virgo rose colored

The earth with the rest of the solar system sun moon and planets is hourly traveling at an incredible speed toward a remote point at one time believed to be a small star in Hercules but astronomers are discovering daily new revelations and our destination is I believe not finally fixed The solar system means our sun and all his belongings whereas the expression sidereal heavens means the sphere of stars as distinct from our solar system

Our sun of course is only one of the stars which adorn the wonderful Star Universe of whose marvels new discoveries are hourly coming to light But the heavens as we see them with the naked eye remain the same from generation to generation Knowledge and Scientific News

* * *

A writer in International and Marine Engineering states that in a new ship it was found that the thrust was running hot and a considerable amount of attention had to be paid to it It was attributed in the first instance to the way in which the cargo was distributed throughout the ship as it was thought that the load had disturbed the line of shafting running from the engine to the propeller In order to minimize the difficulty water was run on to the thrust shoes in order to keep them as cool as possible and in addition the trough under the shaft was kept full of oil so that the revolving collars dipped into the oil and so lubricated themselves In spite of all this however the thrust still ran hot and this presented a problem which was not satisfactorily solved until after twelve months continuous trial It was at last decided however to cut on each of the eight collars four oilways on the headway side These oilways did not run right down to the shaft but very near to it so that they formed four radial pockets for oil When the collar came round each time with the shaft these pockets dipped into the oil and water in the trough and carried some of the mixture round with them This plan enabled the bearing surface of the thrust to be lubricated practically throughout its whole width instead of as before at the circumference and such points as those to which the oil penetrated This increased lubrication device effectively stopped the heating up of the thrust altogether

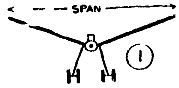
* * *

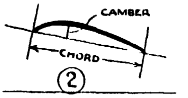
According to Electrical Engineering three Danish engineers recently made public in Copenhagen a new invention by which any telephone subscriber can in the absence of the called subscriber send a telegraphic communication The apparatus at the transmitting end comprises a keyboard like that of an ordinary typewriter and the message is received at the other end on a tape printed in ordinary characters

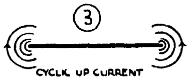
TABLE OF AEROPLANES AT OLYMPIA.*

SOME OBSERVATIONS ON THE THEORIES OF FLIGHT.

We publish this week a table of the aeroplanes at Olympia wherein will be found the leading particulars relating to each machine. These details we were courteously permitted to obtain by direct measurement in cases where the dimensions required were not known by the representative in charge, but in many instances the designers themselves have supplied the particulars. The data that this table contains are particularly interesting at this early stage of the industry and we have endeavored to make the table as complete as possible in respect to those leading dimensions that may be considered as salient in any machine.







SUPPORTING AREA

The first column gives the area of the main planes which in every case carry the greater part if not the whole of the weight. Most machines nowadays have a tail which commonly supports itself in the air and a proportionate amount of the outrigger on which it is carried. Without knowing the exact basis of the design however it is not possible to arrive at values in connection with the action of the tail and in any case the intensity of its loading is far less than the value that obtains in connection with the main planes. The areas given are the result of multiplying the span by the chord with allowances for irregularities in contour.

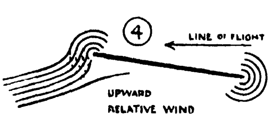
In the second column of the table will be found the areas of the elevators while the third column contains similar particulars relating to the rudder.

SPAN AND CHORD

The next series of columns relate to the principal linear dimensions. The first of these columns relates to the span (1) or width of the machine regarded from in front. The chord (2) is the fore and aft dimension of the main planes measured in a straight line between the leading edge and the trailing edge. The fact that this dimension is actually measured along the chord of the arc formed by the cambered section of the plane is sufficient evidence of the appropriateness of the term as a description of that particular dimension, but it is not without interest to remark that it was comparatively speaking a long time before we had the happy thought that brought this word into use. Up to that time the dimension had always been referred to as the fore and aft dimension of the main plane, a clumsy definition that it was obviously essential to simplify for everyday use. It has been suggested that the dimension should be called fore-aft but although the derivation of such a term is obvious we do not see that it has any advantages over the term that we now use.

ASPECT RATIO

Dividing the span by the chord gives the aspect ratio of the planes and the higher the aspect ratio the greater should be their lifting efficiency. The reason why aspect ratio is important is because the air that spews out laterally over the side edges of the planes represents loss; consequently the length of the side edges should be kept short in proportion to the length of the front and rear edges. In other words the span should be relatively large in proportion to the chord, i. e. the aspect ratio should be large. It is on account of the value of aspect ratio that an aeroplane flies broadside on instead of end on. It is not known how far high aspect ratios might be used with effect but it is certain that the highest practical values are reached before theory would suggest the limit. It is difficult to construct machines having very high aspect ratios so that they shall be sufficiently strong and light for aviation purposes. It is also due to the value of high aspect ratios that the biplane and the triplane exist as types. It would be just as easy, in fact easier, to make a monoplane with as large a surface as any biplane ever built but it would be well nigh impossible to make such a machine with the same aspect ratio. When a large surface is required it is necessary to split it up into two or more sections, that is to say to build a biplane or a triplane. With a triplane it is even easier to obtain a high aspect ratio than with a biplane and it will be observed on reference to our table that the Roe triplane has the highest aspect ratio of any machine with the exception of the Short biplane owned by Moore Brabazon which is a very much larger machine altogether. The least aspect ratio is to be found in the little monoplane of the Santos Dumont type.



CAMBER AND ITS PURPOSE

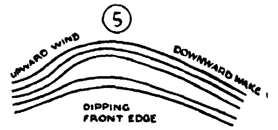
The fourth column in the table devoted to lengths is headed "Camber" (2) and the term has been used to define the dimension that in correct terminology should be expressed as the "maximum versine of the curvature of the fore and aft section of the plane." In other words it is the maximum height above the chord of some point upon the lower surface of the plane. The term "versine" not being generally in use outside geometry and mathematics whereas the term camber is an ordinary dictionary word it is obviously more convenient to use camber in this connection. The values of the camber on different machines are as will be observed rather varied. The least is the amount on the Avroplane but since the camber should always be considered in relationship to the chord which is a small dimension on this machine the amount of the camber does not represent such a flat plane in this case as on the Zodiac biplane where the degree of flatness is quite remarkable. The camber coefficients in the next column which show the camber as a percentage of the chord show the relative flatness of the planes at a glance.

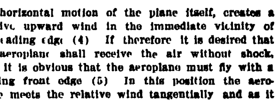
TABLE OF AEROPLANES AT OLYMPIA, 1910.

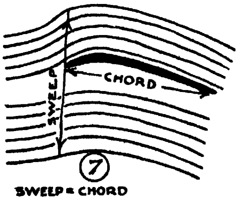
Name	Type	Areas			Lengths								Angles		Screw			In Flight			
		Main Planes	Elevator	Rudder	Span	Chord	Aspect Ratio	Camber	Camber Coeff	Gap	Skid Track	Length O A	Incidence	Dihedral	Diameter	Pitch	Pitch Coeff	Weight	Loading	Speed	
		sq ft	sq ft	sq ft	ft in	ft in		in	%	ft in	ft in	ft in	°	in	ft in	ft in		lbs	lbs per sq ft	m p h	h p
Avis (Aeroplane S Co)	M	160	15	9	28 0	0 6	4 3	4	5 1	—	4 0	27 0	9	26	6 0	—	—	630	3 9	35	25 Anzani
Avroplane (A V Roe & Co.)	T	246	74½	7	24 0	3 6	7 5	1½	3 6	3 3	6 0	24 6	4	22	8 0	3 0	375	550	1 7	40	35 Green
Blériot	M	193	18	5½	28 8	6 8	4 3	5	6 1	—	5 0	24 9	9	—	6 7	—	—	660	3 4	40	25 Anzani
George and Jobling	B	325	38	25	30 0	5 6	5 5	3½	5 3	5 0	4 9	30 0	9½	—	9 0	10 0	1 22	862	2 6	48	60 Green
Gregoire Gyp (Fiat)	M	244	20	8½	34 0	7 4	4 7	4½	5 1	—	5 6	34 0	6° 40	—	7 0	—	—	820	3 4	45	40 Gregoire Gyp
Handley Page	M	150	6	6	32 6	6 0	5 4	2½	1 5	—	6 0	20 6	6	—	6 6	3 6	55	450	3 0	35	20-25 Advance
Henry Farman	B	450	27½	17	34 8	6 6	5 4	4½	5 8	6 0	8 8	43 0	—	—	8 0	4 9	62	1050	2 3	55	50 Darracq
Humber Le Blon type	M	186	11	5	29 2	0 10	4 3	4½	5 2	—	4 5	24 0	—	—	6 11	3 0	5	—	—	—	30 Humber
Do Cap Lovelace type	M	210	16	10	33 0	0 10	4 6	5½	6 4	—	4 9	26 6	6½	11	6 11	3 6	5	—	—	50	50 Humber
Do Biplane	B	482	16	12	40 0	0 8	5 9	3½	4 4	5 0	6 0	33 0	6½	—	6 11	3 6	5	—	—	50	50 Humber
Lane 1 seater (Lane's B A Ltd)	M	195	18	5½	30 0	6 6	4 6	4½	6 1	—	6 0	22 0	—	—	7 0	3 6	5	650	3 3	30	25 N E C
Do 2 seater (Lane's B A Ltd)	M	250	25	7	32 0	7 10	4 1	7½	7 7	—	6 0	22 0	—	38	8 8	4 6	51	970	3 9	30	60 N E C
Mulliner (Mulliners)	M	210	14	4	33 0	6 6	5 1	3	3 9	—	4 2	27 0	10	—	6 1	4 6	71	605	2 8	40	35 J A P
Nicholson (Holland & Holland)	M	227	18	5½	32 6	7 0	4 7	5	6 0	—	4 7½	32 0	9	36	6 8	—	—	800	3 5	—	25 N E C
Ornis (Lascelles)	M	160	10	5	28 0	6 0	4 7	3	4 2	—	4 6	—	—	90	8 0	3 0	37	600	3 8	30	35 Lascelles
Le e (Lec h jault)	M	195	36	7	30 0	7 0	4 0	3½	4 2	—	4 9	29 0	—	—	7 0	3 4	48	740	3 8	30	35 N E C
Santos Dumont (A Clement)	M	108	12	7	18 0	6 6	2 8	3	3 8	—	3 0	21 0	7	11	6 6	2 6	38	530	4 9	40	32 Clement
Do (Mann & Overtons)	M	128	16	6½	18 4	7 0	2 6	3½	3 9	—	3 8	20 0	—	—	6 6	—	—	536	4 2	45	30 Anzani
Do (Aeroplane S Co)	M	143	7½	5	22 0	6 6	3 3	2½	3 5	—	4 3	26 0	—	—	6 7	3 0	45	465	3 2	50	30 Dutheil Chalmers
Short (1909) (Short Bros)	B	280	55	10	31 8	5 4	6 0	3½	5 1	4 4	4 6	31 0	—	—	7 6	—	—	857	3 1	45	35 Green
Do (Moore Brabazon)	B	450	45½	7½	48 8	6 6	7 5	4	5 1	6 8	—	—	3	—	9 0	—	—	—	3 3	45	
Short Wright (Short Bros)	B	515	44	23	41 0	6 8	6 15	—	—	6 2	5 8	29 0	—	—	8 6	—	—	—	—	—	
Sommer (Hon C S Rolls)	B	450	45	9	34 0	6 8	5 0	4	5 0	6 0	9 0	—	—	—	—	—	—	—	—	—	
Spencer Stirling (Berliet Motors)	M	200	19	6	34 0	6 0	5 6	3	4 2	—	5 0	27 0	10	17	6 6	10 0	1 6	850	4 3	40	40 R H
Star	M	290	20	20	42 0	8 0	5 3	4	4 2	—	5 0	32 0	8	13	6 6	3 9	58	950	3 3	30	40 Star
Twining (Twining & Co)	B	252	25	6	28 0	4 6	6 1	4½	8 3	5 0	4 0	14 7	7	24	6 3	4 6	71	450	1 8	35	20 Phœnix
Warwick Wright	M	160	14	6	27 0	6 6	4 2	4½	5 8	—	4 0	29 0	9	24	6 0	2 3	37	405	3 8	35	40 F N V
Zodiac (British & Colonial Co)	B	475	22	10½	33 3	5 11	5 5	[illegible]	2 6	5 9	6 6	39 3	—	—	8 3	—	—	1100	2 3	35	50 Darracq

NOTES.—*Types* B = biplane; M = monoplane T = triplane
Blériot monoplanes were shown by L. Blériot, Blériot Ltd. and the Aeroplane Supply Co

Aeroplanes are cambered because the lifting efficiency of the cambered plane has been found to be very much greater than the lifting efficiency of a perfectly flat plane inclined to the line of flight and the reason that it should be so is not difficult to appreciate although it is often misunderstood. One inseparable consideration that must be taken into account in connection with the cambered plane is the theory of the dipping front edge. An aeroplane does not fly with its leading edge tangential to the line of flight as some people suppose but has its leading edge dipping down so as to be tangential to a relative upward wind. This relative upward wind actually exists as the result of what is known as the "cyclic up-current" in the vicinity of the leading edge. If a flat plane be dropped face downward through the air the air will be caused to spew out around the edges of the plate (3). As the plate falls the air in the vicinity of the edges will flow upward from beneath the plate in order to make good the displacement or tendency to create a vacuum that occurs in the wake of the plane. There is thus a transference of air from beneath the plate to the space above the plate always going on while the plate is in motion through the air and it is obvious that this cyclic up-current exists whether the plate be falling to earth or traversing the air in any other direction. It exists in the inclined aeroplane and being compounded with the horizontal motion of the plane itself, creates a relative upward wind in the immediate vicinity of the leading edge (4). If therefore it is desired that the aeroplane shall receive the air without shock, then it is obvious that the aeroplane must fly with a dipping front edge (5). In this position the aeroplane meets the relative wind tangentially and as it is driven onward through the air its camber converts the upward wind into a downward stream in the wake. In effecting this reversal of direction the aeroplane has exerted a downward force that by Newton's law, exerts an equal and opposite upward direction. This is how the aeroplane develops its lift or capacity for supporting itself in flight.







THE GAP AND WHY IT IS EQUAL TO THE CHORD.

The sixth column in the table of lengths contains dimensions relating to the gap of multiplanes (6). The gap is the vertical height between one plane and that which is immediately above it. It will be observed that the gap is in most cases approximately equal to the chord. It is not really [illegible] small a gap may be used in a biplane or triplane, but such evidence as exists, points to the conclusion that it should be approximately the same dimension as the chord, and this is common practice at the present day Merely from a constructional point of view it would be advantageous especially on large machines to have a small gap, but if the gap is too small there is a loss of lifting efficiency owing to interference between the two planes An aeroplane sweeps downward a stratum of air of unknown dimensions but it is supposed that the depth of the stratum or sweep as Lanchester has called it is effectively equal to the dimension of the chord (7). The stratum extends

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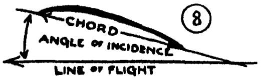
* Flight.



equally above and below the aeroplane for the air follows the contour of the upper surface just the same as it follows the contour of the lower surface If therefore a biplane is made with a gap equal in dimension to the chord it may be assumed in the light of present knowledge or shall we say absence of knowledge that there is no serious interference nor consequent loss of efficiency

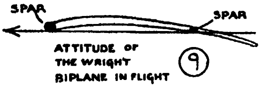
SKID TRACK

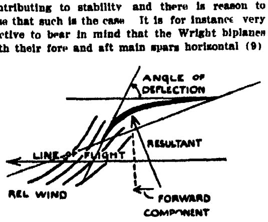
The skid track for which dimensions are given in the last column but one of those devoted to lengths is an important dimensions of an essentially practical character It corresponds to the track of the wheels on a motor car but with the difference that whereas the motor car is a fairly compact machine with a considerable amount of natural stability the aeroplane is very top heavy at the best of times and is always wanting to fall over even on land Too little attention has in our opinion been paid to this dimension in the design of several of the aeroplane chassis, but on the other hand there are also many examples of machines that have a good firm tread upon the earth

The last dimension given in the column of lengths is the overall length of the machine which taken in conjunction with the span indicates the approximate size of the hangar or shed that is required as a housing

ANGLES OF INCIDENCE AND DEFLECTION

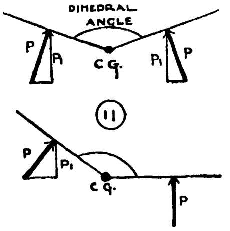
The next series of figures relate to the angles and have been somewhat difficult to obtain nor do we make any great claim for their accuracy The angle of incidence (8) is the angle that is made by the chord to the line of flight and in modern machines it seems to have a positive value varying between 3 and 10 degrees It is less in biplanes than in monoplanes owing to the relatively large area of such machines For our own part we are inclined to regard the present-day knowledge on this matter of the angle of incidence as being in an altogether unsatisfactory state and we should very much welcome some really reliable data on the subject From what we have said above about the dipping front edge it will be observed that there is no need to have a positive angle of incidence at all in order to get a lifting reaction from a cambered aeroplane On the other hand it appears that some positive angle is regarded as contributing to stability and there is reason to suppose that such is the case It is for instance very instructive to bear in mind that the Wright biplanes fly with their fore and aft main spars horizontal (9) so that the three degrees or so of positive angle of incidence is entirely obtained with the trailing portion of the plane that projects behind the aft main spar





We have taken this opportunity of drawing particular attention to the subject, because it is likely to come in for a very considerable amount of discussion in the near future. We observe, for instance in the model section, an exhibit, by W. F Howard, of a monoplane designed to fly with a negative angle of incidence to the chord, in connection with which it has been sought to demonstrate a certain theory of vortex motion We do not wish to discuss this vortex theory, but we do wish to draw attention to the fact that a negative angle of incidence to the chord is not necessarily at all the same thing as a negative angle of incidence with a flat plane

It seems to us that the effective angle is that represented by the angle of deflection (10) that the stratum of air is caused to bend in order to create the lifting reaction whereby the machine is supported in flight It is obvious that an aeroplane having a dipping front edge and a horizontal trail (10) would have its chord at a negative angle in flight If as the result of actual experiment it were proved that an aeroplane were more efficient when its leading edge were dipped down so much more than its normal position that its trail became horizontal then we should be inclined to assume this evidence primarily as an indication of the presence of an upward trend in the relative wind having a steeper slope than had been supposed We imagine that anyone conducting such experiments would immediately increase the fore and aft dimensions of the plane in order to again deflect the trailing edge without altering the leading edge because it would seem evident that the full opportunity for obtaining reaction by deflection of the air has not been taken if the aeroplane has a horizontal trail

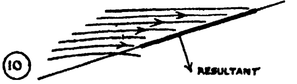


A cambered aeroplane arranged with a negative angle of chord would presumably have a resultant pressure inclined forward of the vertical which would produce a horizontal component of thrust in the direction of flight It must be borne in mind however that such a favorable force has to be paid for by engine power and there is no particular point so far as we can see in utilizing the direct thrust of the propeller for the purpose of indirectly recreating another forward thrust in the aeroplane The purpose of the propeller thrust is to overcome resistance which is essentially a retarding force and is made up of two factors the aerodynamic resistance that provides the vertical lift overcoming the force of gravity and the direct resistance represented by the skin friction of the struts planes and spars

LAWS OF FLIGHT RESISTANCE

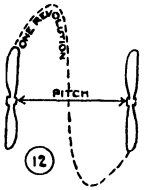
It may be of interest while dwelling on this subject to recall the laws that govern these resistances For a given weight supported the aerodynamic resistance varies inversely as the square of the speed while the head resistance varies directly as the square of the speed The reason why the aerodynamic resistance varies inversely as the square of the speed is because the angle of incidence varies inversely as the square of the speed and because the aerodynamic resistance is proportional to the product of the angle and the weight In other words if the speed of flight be doubled the aerodynamic resistance will be reduced to a quarter of its former value

Now it is most important to bear in mind that this law applies to aerodynamic resistance alone and that it has no meaning whatever unless taken in conjunction with the law of direct resistance This law as mentioned above states that the head resistance varies directly as the square of the speed consequently the faster the machine flies the greater will be the power expended on this resistance



Langley, the renowned American investigator of aerodynamics, seems to have regarded skin friction as negligible and to have been under the impression that the inverse law relating to aerodynamic resistance could be accepted by itself, at any rate his published statements certainly imply that the higher the speed the less the power required

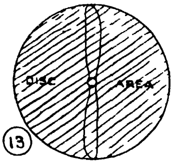
It is quite easy to understand however that it is only economical to reduce the aerodynamic resistance to an amount that is determined by the relative head resistance because, when two factors obeying absolutely opposite laws have to be taken simultaneously into consideration there is one value for each, and one value only that produces a minimum sum in combination The great problem that confronts the designer of an efficient aeroplane is the selection of angles areas and dimensions of struts so that the total resistance of the machine in flight shall be the least possible for the load supported



THE DIHEDRAL ANGLE PROBLEM

Reverting again to the table which forms the basis of our present remarks the next column to come under consideration is that representing the dihedral angle made by the wings of many of the monoplanes A dihedral angle is an angle made by two surfaces that do not lie in the same plane In respect to aeroplanes it might be described as the V setting of the wings Its purpose is to endow the machine with a certain amount of natural lateral stability and the theory or rather theories associated with the dihedral angle formed the subject of a most interesting correspondence in Flight last year In our description of the Antoinette monoplane (Flight vol I p 662) which was the first of the monoplanes to have the dihedral angle in a very marked degree we sought to explain the theory of natural stability associated therewith by means of simple diagrams

These diagrams are again reproduced and as we have seen no cause to change our original theory we will again put forward the same explanation The air pressure on an aeroplane is assumed to be normal i e perpendicular to its surface hence in the accompanying diagrams (11) the lines *P* represent the air pressures on each wing separately These pressures are inclined from the vertical but they produce by the ordinary laws of component forces two vertical components *P* that are sufficient to overcome the force of gravity and support the machine in flight When the machine is canted over as shown in the lower diagram where the right hand wing is represented in a horizontal position the full value of *P* acts vertically upward on the right wing whereas the vertical components *P* of the pressure on the left wing is reduced The values of *P* however are still equal to one another on both wings Now if the machine were pivoted upon an axis *fixed in space* the mere fact that the two values of *P* remain unchanged would be sufficient to keep the machine in equilibrium in any position and would therefore prevent a restoration to the attitude represented in the first diagram A flying machine however does *not* proceed along a *fixed axis* in space it can rise or fall as a whole and this fact causes the lower diagram to represent an unstable condition embodying a couple tending to restore the machine to its original attitude



The canting of the machine has not shifted its center of gravity C G which for convenience is assumed to be situated at the junction of the wings and consequently it has not altered the proportion of the load carried by each wing It will be observed therefore that the upward force on the right wing is superior to the load it has to carry whereas the upward force on the left wing is inferior to its load The result is obvious, the right wing will lift a little and the left wing fall until the loads and the lifts are again balanced It is not necessary nor is it probable, that this restoration of equilibrium takes place through an axis passing through the center of gravity, it is quite likely that the center of gravity falls a little through space in the operation

In the table we have for convenience given the amount of the dihedral angle as a slope of 1 in X"

It will be noticed that there is a considerable difference in the values

THE DIAMETER AND PITCH OF PROPELLERS

The next series of figures in the table relates to the propeller or tractor screw as the case may be A tractor screw is merely a propeller situated in front of the machine so that it pulls instead of pushes Most monoplanes have tractor screws and the pros and cons of the arrangement were discussed in our article on the Olympia Show last week

The first column of figures relating to screws in the table gives the diameters of the various propellers and it will be observed that there is not a great deal of variation in these dimensions The next column gives the pitch but it has not always been possible to obtain this value owing to the fact that it can not be readily measured The pitches given in this column are those represented by the angle of the blade If for instance the pitch is given as 3 feet it means that the machine would advance 3 feet through the air per revolution of the propeller (3) if the propeller blade were mounted in *solid* guides so that there was no possibility of slip The air is not solid in this way however it is in fact only capable of offering an abutment for the thrust of a propeller by virtue of being accelerated backward in the form of a rearwardly moving stream This stream is called the slip and it represents a percentage (in the order of 0 per cent) of the pitch so that the machine does not advance through the air by the full amount of the angular pitch per revolution of the propeller

THE VALUE OF THE PITCH COEFFICIENT

The third column of figures relating to the screws in our table gives values of the pitch coefficients which are obtained by dividing the pitch by the diameter In most cases it will be observed that the pitch is in the order of one half the diameter but that in one or two cases the pitch is greater than the diameter in other words the pitch coefficient exceeds unity The pitch coefficient is a very important factor in the efficiency of a propeller and marine experience has taught designers of propellers for that purpose that a pitch coefficient in the order of unity should be obtained even with high speed propellers (See Flight vol I page 0) Now it is possible in any propeller to have a pitch coefficient of unity if it is desired but if those propellers that have a pitch coefficient less than unity in our table were altered to have a pitch coefficient of unity then they would either have to run at a slower rate of revolution speed or be made smaller in diameter Those propellers that have a high pitch coefficient in our table are all indirectly driven from the engine through gear reduction mechanism

The natural high speed of a gasoline engine does not apparently at the moment permit of the use of a propeller of reasonable diameter with a high pitch coefficient and it is necessary to have a reasonable diameter in order to get sufficient disk area The disk area of a propeller (1) is the area included in the circle described by the tips of the blades as they revolve This disk area represents approximately the cross section of the slip stream in other words it indicates the mass of air to which rearward acceleration is being imparted If the mass is large the velocity necessarily imparted to it in order to obtain the thrust required will be small whereas if the disk area or diameter of the propeller is small the velocity imparted to the slip stream will be high Now whereas the power lost in the slip is only directly proportional to the mass of air in motion it varies as the square of the velocity with which that mass is moving consequently it is desirable to keep the velocity low by using a large diameter The best proportion between mass and velocity is given in the light of marine practice when the pitch coefficient is unity but in aeroplane construction the use of a direct driven propeller on a modern high speed engine would cause the propeller diameter to be unreasonably small with such a coefficient consequently designers have sacrificed the coefficient rather than the diameter On monoplanes with tractor screws there is a very good reason for this too owing to the large amount of obstruction caused by the body of the machine If the screw were much smaller in diameter than it is practically its whole area would be screened in some cases

The pitch coefficient of a propeller is a factor that indicates the limiting brake angle If the pitch coefficient of a propeller is unity for instance then the boss of the propeller will advance axially an amount equal to the diameter of the propeller while the tip of the blade moves through a path equal in length to the circumference The ratio of these two movements is one to π, or approximately one to three, which ratio represents the tangent of 18 deg This, therefore would represent the angle made by the tip of the blade to the plane of revolution

WEIGHT LOADING AND SPEED

The final series of figures contained in our table relate to weight loading and speed The weight given is the weight of the machine in flight and includes in every case an arbitrary allowance of 200 pounds for the pilot and fuel Dividing the weight by the area of the main planes we have obtained the figures given in the column of loading These figures represent the intensity of air pressure in pounds per square foot that must be obtained upon the main planes in order to maintain horizontal flight It has been assumed that the whole of the load is carried on the main planes, except in the case of the Roe triplane where the tail is definitely constructed to be a load carrying surface It is not strictly accurate to omit the supporting effect of the tail in other machines but it is difficult to give proper value to this factor and for convenience it was omitted altogether It will be observed that the loading values of most of the machines are above 3 pounds per square foot and go as high as nearly [illegible] pounds on the little Santos Dumont monoplane On the Roe triplane the loading is small owing to the large surface that is easily available with a triplane and to the lightness of construction in this particular machine In the Twining biplane the low loading value is due to the small weight of the machine which in turn is partly caused by the use of a light rotary engine and by the complete absence of a tail In the Santos Dumont type of monoplane the loading value is high because of the small area A high loading value implies that it will be necessary to fly very fast or at a very steep angle of incidence but the figures that we have been able to obtain relating to the speed in flight are unfortunately of such a character as to make it impossible to deduce any interesting or important conclusions by way of comparison Much the same remarks also apply to the engine power required for flight on which we purposely omit to make any observations

THE FOOD SUPPLY OF THE FUTURE.*

A PROBLEM FOR AGRICULTURAL INSTITUTIONS.

BY H. P. ARMSBY.

FROM various sources we have heard of late warnings of a deficiency in the food supply of the future population of the United States

Thus President James J Hill in his address before the Bankers Association and more elaborately in his recent article in The Worlds Work sets forth in striking terms the growth of our population and the present limits of wheat production and predicts a shortage of not less than 400 000 000 bushels by the middle of the present century unless radical improvements in the prevailing methods of farming are speedily inaugurated

Davenport in his address at the dedication of Agricultural Hall at the University of Maine calculates that if the rate of increase of population in the past one hundred years be maintained the end of the twentieth century will see us with a population of twelve hundred millions and emphasizes the fact that the agriculture of the future must be enormously productive in order to feed these teeming millions He says

The conditions that have just been discussed will not be temporary and transient they will be enduring yes everlasting and they must be met by a permanent agriculture a thing the world has never yet succeeded in establishing No race has ever yet learned to feed itself except at the expense of the fertility of its own or some other country Other races have come up against this problem and have gone down under it

There is to be in the very near future a struggle for land and the food it will produce such as the world has never yet beheld He who knows where and how to look can see it coming The African activity among western European nations is a part of it It is always cheaper to move when over population and failing fertility threaten a shortage of food—providing there is any place to move into that is providing we can dispossess the other party and his land is worth the contest

However that may be as an abstract proposition for us there is no moving For us there are no more new worlds For us there is little more out west Our fortune and our future whatever they may be are staked down on the American continent Literally here we rest and whether we like it or not we must devise and establish a permanent agriculture or go down in the attempt

Much the same general line of thought was followed by President J L Snyder in his annual address before the Association of American Agricultural Colleges and Experiment Stations but with special emphasis on the social significance of a straitened food supply He said

Agriculture has contributed to democracy more than we can estimate by furnishing our people with an abundant food supply So fertile has been our land so extensive our fields so abundant our harvests of grain and fruit that the best and highest grades of food have been within the reach of every citizen who has been willing to do an honest days work It matters not what his occupation and social position be they ever so humble He and his family enjoy practically the same kinds of food as that enjoyed by families of wealth and prominence In the dinner pail of the man who works in the mill in the mine or digs the ditches in our city streets can usually be found wheat bread meat butter fruit and coffee What more does any one have?

Caste and class distinction can make little headway among a people who all live on the same kind of food As long as the working man has in his tin pail as good a dinner as his superintendent or as the mayor of his city his prejudices will be moderate He will maintain his self respect and feel and act the man It is when the pangs of hunger begin to pinch that men give way to prejudice and passion"

After pointing out that unless the food supply keeps pace with the increase of population there will not be enough of the better foods to go around he says

The history of other countries tells us what would soon follow Two families could not or would not occupy the same pew in church while one lived on white bread and meat and the other on black bread and potatoes There is a social distinction there that cannot be bridged They would not even attend the same church or belong to the same social organizations Our people would separate into classes and become estranged from each other The power usually goes with wealth but the men compelled to live on cheap food would soon get into the same political party and perhaps gain control of the national government

and quotes from a letter of Lord Macauley to an American friend as follows

The day will come when the multitudes of people none of whom has had more than half a breakfast or expects to have more than half a one will chose a legislature Is it possible to doubt what sort of a legislature will be chosen? There will be I fear spoliation The spoliation will increase the distress the distress will produce fresh spoliation Either civilization or liberty will perish

Even if we question the estimates of rate of increase in population on which these warnings are based and however much weight we may attach on the other hand to estimates of increasing agricultural production per acre it would be foolish in the extreme to close our eyes to the fact that the intensity of the demand for food by our future population will exceed anything we have yet known Whether this state of affairs is to come about more or less rapidly is important chiefly as it gives us more or less time to prepare for it

This is not the occasion to discuss problems of crop production nor of the conservation of soil fertility but there are other aspects of the question which intimately concern us as stock feeders

The problem of food supply is essentially a problem of energy supply While a small proportion of our food during the earlier years of life serves to build up the bodily machinery, by far the larger part of it is simply the vehicle by means of which chemical energy is introduced into an organism to be liberated again as work or heat in the performance of the vital functions. Briefly and crudely stated, the food is the fuel of the body. The ultimate source of this energy, so far as we are concerned, is the sun. Crops are produced by means of solar radiation and food represents the stored-up energy of the sun's rays. The continuance of life upon the earth is conditioned upon the ability of the plant to effect this storage of energy, and the density of population which a country can support from its own resources is limited absolutely by the amount of solar energy which can be recovered in the form of food products

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*Presidential address delivered before the American Society of Animal Nutrition at Chicago Ill

In view of this absolute dependence on solar radiation, it is a rather startling fact that the larger part of the energy stored in an acre of crop is contained in inedible products. From one-half to two-thirds of the organic matter of the corn crop, for example, is contained in the stover and cobs, and about sixty per cent of that of the average wheat crop in the straw Furthermore, grain itself is not adapted for direct consumption by man, but undergoes various processes of preparation, giving rise to numerous unavailable by products For example, in the milling of wheat, about 25 per cent of the grain passes into the offals, and only 75 per cent serves for purposes of human nutrition In other words, out of the total energy stored up by the growth of an acre of wheat only about 30 per cent serves directly for the nutrition of man Substantially the same thing is true in greater or less degree of other food crops, while the grasses and leguminous forage crops which play so important a role in modern agriculture are, of course, entirely useless as human food

It is clear that as population becomes denser and agriculture more intensive, it will become essential to utilize the energy of these by products as completely as possible When we number 500 000,000 we cannot afford to throw 60 per cent of the energy of the wheat crop into the manure heap if it is possible to save any of it. The agency for effecting this saving is our domestic animals. They are able to consume these by product materials which man cannot use and to render available a portion of their energy, using it in the first instance to support their own lives, but also storing up for man's use a certain part of what would otherwise be a total waste As the demand for food grows more intense, it will become increasingly important to so husband these by products and combine them into efficient rations, and to feed these rations under such conditions and to such types of animals, as to save the largest possible percentage of the energy which they contain.

It scarcely need be said that we are still far from doing this Our rations are too often faulty and fed to inferior animals under unfavorable conditions, and only a short railway journey is necessary to convince one of the enormous waste of forage taking place every year, while our by-product feeding stuffs compete with native products in the markets of the old world.

With our relatively sparse population this has hitherto been a country not only of cheap food, but especially of cheap meat, and we have been fond of drawing the contrast between the diet of our laborers, with its abundance of animal food, and that of the European laborer, and whether rightly or wrongly, have attributed much of the greater efficiency of our workmen to this difference in diet This abundant meat supply has been drawn especially from the vast corn fields of the Mississippi valley Not only have our by-products gone to waste, but material available as human food has been converted into meat and milk While this concentration of grain into higher priced and more marketable products has been in the past and to a degree still is entirely justified economically, nevertheless, the conversion of corn, or of any food grain, into meat is an exceedingly wasteful process. Jordan* computes that in the production of beef or mutton only about 2 2/3 per cent of the digestible organic matter consumed by the animal is recovered as human food in the edible portion of the carcass, while even in pork production this percentage rises to only about 15¼ per cent Facts like these make it evident that we can not continue indefinitely to use edible grains as stock food—to take the children's bread and cast it to the beasts. The waste of energy in the transformation is too great Nor is it any answer to say that wheat and not corn is the bread grain of the western world. The irresistible economic pressure of population will sooner or later compel us either to use corn as human food or to utilize the land now devoted to corn culture for other crops which shall yield more available nutriment, while the stockman will be forced to utilize by-product feeds to the utmost, not simply as a means of continuing meat as a prominent ingredient of our diet nor of providing animal foods as luxuries for the tables of the wealthy, but primarily as a means of conserving energy for human use. The feeder of the future will utilize by-product feeds to an extent as yet unrealized. He will pass in review the crude products of the farm, and all the hundred and one wastes of manufacturing operations, to see if perchance they still contain energy which he can extract. Like the miner, he will be ready to work low grade ore, provided there is a sufficient margin of profit. Even the small amounts of available energy contained in such feeds as oat hulls, corn and the like will be utilized and their waste energy saved as rapidly and as far as economic conditions render profitable, and to aid in rendering this possible is to render service to mankind.

It must be clearly understood, however, that this desirable end is not to be attained by any species of pious fraud The manufacturers of mixed feeds are of late making much of the importance of by product materials, a most sound proposition in itself, but one which hardly justifies all the corollaries which some of them appear to draw from it That corn cobs, for example, contain a certain small amount of available energy does not render it an act of benevolence to induce the farmer to feed them, as Mike wanted his whiskey supplied, "unbeknownst," in some fixed feed with a high sounding name or as an inconspicuous admixture to some well known material Such surreptitious kindness is in danger, in the long run, of recoiling upon its author. We shall not effect the needed economies of the future by coaxing or beguiling the feeder into utilizing these low grade materials as ingredients of patent feeds or pre-digested mixtures or ready balanced rations, but by teaching him their true value and educating him to make his own mixtures and balance his own rations. Personally, I am opposed on principle to mixed feeds, as I am to mixed fertilizers, not because many of them are not good of their kind, but for the reason that they minimize the intelligence of the farmer while they open a wide door for fraud on the part of unscrupulous manufacturers and dealers

The questions which we have been considering are very broad ones They signify nothing less than a revolution, no less real because gradual, in the methods of agriculture as a whole and of the production of animal foods in particular, and the conditions which we must expect in the future will call for a much higher degree of skill in adapting means to ends than has been necessary in the past. What, then, should be the attitude of the institutions for agricultural teaching and research toward the problem of the future food supply?

Hitherto a large share of our experiments in feeding have had for their chief aim the improvement of present practices. They have sought to demonstrate how we may most efficiently convert grain into meat rather than how much of it can be saved for man's direct use. While such experiments have been of undoubted immediate utility, yet we shall soon have to reverse the point of view Our experiment stations must take up in earnest the conservation rather than the exploitation of food resources, and our agricultural colleges, while still teaching the approved practices of the present, must as their chief aim seek to equip their students with a sound knowledge of underlying facts and laws and thus prepare them to meet the changing conditions of the future. In passing, too, I can not forbear calling attention to the fact that such an attitude toward the subject of animal husbandry and such methods of teaching it will serve to impart to it a higher pedagogic value than it generally has at present and will tend to make it a disciplinary as well as an informational subject

Investigation of the questions here outlined must be of as broad and comprehensive a character as the problems to be solved. It should proceed, as I view it, along two main lines

The first of these is a far more extensive and profound study of the scientific principles of animal nutrition than has yet been made

That he may utilize the materials of which I have been speaking as completely as possible, the stockman needs to know in the first place what proportion of the energy which these various materials contain it is possible or practicable to recover This knowledge will enable him to effect a wise selection in the compounding of rations, as well as to have an influence upon the whole system of farming In the second place, he needs to know the relative efficiency of different species, breeds and types of animals as converters of energy and how their efficiency is influenced by their natural or artificial environment

These however, are questions of animal physiology. In effect they ask how does the animal mechanism operate when supplied with different raw materials or placed under varying conditions They are problems for rigorous scientific research and too much stress can not be laid upon the importance of such research. A well known investigator, in a private communication from which I am permitted to quote, says:

"If we are to find new things, to get new ideas and to establish new lines of practical experimentation, we must first increase our field of opportunity by discovering new facts of general application The progress of every branch of applied science has been made in this way and agriculture as well as the mechanic arts has shared in the benefits. The immense improvements of recent years in agricultural practice are largely founded on the purely scientific investigation of the preceding generation. The progress of the future must be founded on the scientific research of the present That researches directed to immediate practical results frequently fail to yield all that may be expected of them is largely due to the imperfections of the scientific work of the past and so makes evident the importance of undertaking in the present purely scientific studies which will lead to more definite and valuable results when future experiments are directed to the solution of practical problems

"No field of study opens so widely or presents so many opportunities for gaining knowledge of untold practical importance as that of animal nutrition

"As an illustration of the importance of gaining information respecting the fundamental problems of nutrition, the knowledge gained during the last few years respecting the constitution of the proteins may be mentioned

'As a result of these recent discoveries the whole question of protein assimilation is put in an entirely new light, multitudes of new questions are raised which must be answered before the feeding of these substances can be carried out on a scientific and intelligent basis Heretofore in conducting feeding experiments proteins have been assumed to be of equal nutritive value and no definite evidence has been obtained which shows whether or not this is so The wide differences in the constitution of the proteins of different animal and vegetable tissues at once raises the question of their relative nutritive value and the best methods of feeding them Definite information respecting the nutritive value of each of the proteins commonly employed for food can not fail to show the way to new experiments with the use of commercial feeding stuffs and ought sooner or later to show the way to more productive and economical uses of these foodstuffs A similar knowledge of the actual nutritive relations of phosphorus containing substances* would likewise doubtless lead to similarly important results and deserves far more attention from a purely scientific standpoint than it has yet received.

"Concerning all these questions we know something, but how little this is in comparison with what remains to be discovered These are hard problems but they must be solved before agricultural practice can have the benefit of what science can do for it"

Such work is intensely individual in character The prime factor is the man The principal service, and a highly important one, which an organization can render is to aid in providing the opportunity Such service I earnestly hope our society may be able to perform, especially in the direction of impressing upon public sentiment as represented in legislative bodies on the one hand, and upon the minds of benevolent men of wealth, on the other hand, the fundamental importance of scientific research for the successful solution of the problem of the future food supply

The other main line of experimental effort relates to the economic application in practice of the principles discovered by scientific investigation. Along this line, as I see it, there is a wide field open for fruitful experimental work, but this aspect of the subject was so fully dealt with last year in the report of the committee on organization that it seems superfluous to enter into it anew at this time

Finally, along both lines of effort but especially the second, there should be a co ordination of effort and of spirit combined with the largest possible scope for individual initiative This society owes its origin largely to a feeling of dissatisfaction over the more or less fragmentary and elementary nature of our past work The discussions of the Cornell conference and of the last annual meeting of the society as well as the incorporation into its constitution of the provision for a committee on experiments, clearly shows a desire on the part of investigators for closer relations with each other and a more broadly conceived program of investigation It is hoped that the meetings of this society and the work of its committee may at least be serviceable in defining problems and improving methods

But no program of agricultural investigation can be truly national in its scope which does not include the greatest agricultural agency perhaps in the world certainly the predominant one in this country—the United States Department of Agriculture No one would think of intimating that this great department has neglected the interests of the stockmen of the United States, but nevertheless, it is true that until very recently its work for them has been chiefly of the nature of veterinary and inspection work, as indeed it still is to a relatively large extent The Bureau of Animal Industry has, it is true, established a dairy division and has begun to take up problems of feed ing and especially of breeding with the modest appropriation for this purpose which Congress has put at its disposal The department should be put in position to do much more than it is doing however Its work in this field should be productive as well as protective If the development of our waterways and the conservation of our forests mines and water powers are subjects of national concern surely the conservation of the food supply is worthy of attention The magnitude of the live stock industry in itself and especially its important relations to the future food supply of the nation which I have been endeavoring to point out are such as to amply warrant the department in entering upon comprehensive investigations both scientific and practical into this subject and to fully justify Congress in making all necessary appropriations It is not alone our food supply but our democracy which is at stake

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* "The Feeding of Animals," 8th edition, p. 405.

* The experiments of McCollum, at the Wisconsin station, published since this was written, are most important on this point.

It goes without saying that such an effort on the part of the national government should be made in harmony with the investigations which may be undertaken by other agencies All the available forces should unite in the study of these important questions and no local jealousies should be allowed to stand in the way While there may be problems of co-ordination and correlation still to be solved I am confident that they are readily solvable while it seems not impossible that in some respects this society might advantageously serve as an unofficial intermediary between state and national authorities

I congratulate the society upon the notable increase in its membership during the past year and upon the very encouraging attendance upon its first annual meeting If I understand the spirit and temper of its members they desire to make the society something more than a pleasant club or a gathering for the reading of papers It is my hope which I believe I share with every member that it may become an active agency in forwarding the solution of some of the problems which I have attempted to indicate in this address

* * *

In an article published in the Phys Zeitschrift W Krebs discusses the dimensions of the earth's nucleus The periods of 33 60 and 24 minutes found in seismograms are discussed Oddone considers 33 and 60 minutes to be the times taken by the first and second phase waves to travel to the antipodes and back i e a distance of two terrestrial diameters Krebs regards the 24 minute as the time taken by the preliminary tremors to travel through the earth's nucleus to its antipodal boundary and to return after reflection there He thus obtains 9 8 0 or 10 026 kilometers as the diameter of the nucleus according as he adopts Wiechert's or Benndorf's value for the velocity of propagation in the nucleus relative to that in the crust

ENGINEERING NOTES.

Before the International Association for Testing Materials, L Guillet and L Revillon read a paper on impact tests at variable temperatures Reference is first made to the work of Charpy who found that resilience i e, the specific work done in fracture—first increased as the temperature rose to 150 deg C and decreased afterwards reaching a minimum between 400 deg and 500 deg Tests have been carried out with a view to investigating blue heat brittleness, on carbon steels of increasing carbon content nickel steels and one nickel chrome steel The specimens were broken in a Guillery machine on an anvil with a 1 57 inch opening and with an initial energy of 434 feet pounds The results showed that the resistance to shock increased up to a temperature of 200 deg C when it fell gradually to increase again when the steel was red hot The temperature of maximum fragility was always the same and equal to 475 deg C a red glow temperature This is not the so-called blue heat, 300-325 deg C There was a maximum resilience, less fixed, at 150 deg to 200 deg C depending on the nature of the steel at this temperature all the specimens showed a strength of at least 72 feet pounds For one of the most brittle steels 36 feet pounds was obtained in the cold and 72 feet pounds at 200 deg C The minimum resilience observed at 475 deg C was below the value observed at ordinary temperatures, the difference amounted to 43 50 feet pounds and this decrease was the greater the softer the steel For nickel steels the figures were 180 feet pounds at ordinary temperature and 87 at 475 deg C Nickel chrome steel showed a marked constancy 115 feet pounds in the cold and the same at the minimum and the curve ascended very slowly beyond the minimum The results do not account for the fact that a soft steel sheet can be broken at a blue heat

The character of coal in relation to smoke prevention was the subject of a paper read by Mr D T Randall before the Syracuse meeting of the National Association for the Prevention of Smoke Mr Randall stated that the semi bituminous coals which are the most extensively used for steam generation require especially designed furnaces and careful operation to obtain good results The volatile matters from such coals are set free more readily than from other types of coal and in the case of some bituminous coals the volatile matter given off on heating is exceptionally difficult to burn Smoke is an indication of incomplete combustion and its reduction is important to the fuel user since much potential heat may escape with the unconsumed gases present in the smoke A table is given from the U S Geological Survey Bulletin No 325 showing that the percentage of CO in the exit gases increases with the percentage of black smoke The losses of heat due to the presence of this gas and of hydrogen in the exit gases from the boilers vary from 1 to 10 per cent, and are always a feature of a smoky chimney In order to obtain perfect combustion of the gases given off by bituminous coals, a high temperature an adequate supply of heated air, and a large combustion space are required In most plants, the gases pass from the fuel bed to the top of the chimney in 10 to 15 seconds, and therefore the gases must pass through and away from the combustion chamber in 1 second At the end of this brief period, therefore combustion must be complete This fact makes clear the necessity for a sufficient air supply, properly distributed, and for an ample combustion space above or at the back of the grate A good furnace should permit the burning of bituminous coal in sufficient quantities, without loss by escaping CO or hydrogen gas when the air supply is about 50 per cent in excess of the theoretical amount It has been found by experience that mechanical stokers, with a coking plate can best provide the essential conditions requisite for the complete combustion of these coals A furnace suitable for one class of coal may however, be entirely unsuited for others and a careful study of all factors named above is required, in order to design a furnace which shall be smokeless and economical with the particular fuel selected for use

TRADE NOTES AND FORMULÆ.

Varnish for Securing Transfer Pictures to Earthenware Goods.—13 parts of mastic, white rosin 25 parts, Venice turpentine 54 parts sandarac 50 parts, 98-degree alcohol 160 parts, dissolved at a moderate heat

Cleansing Medium for Gilded, Bronzed, and Similar Articles—A mixture of 10 parts burned alum and 30 parts of soda lye, with 500 parts of water, with which about 7 parts of celluloid varnish is intimately mixed This is the substance of an Austrian patent application

Production of Pure Caseine.—Allow milk to stand in a cool place and very carefully remove the cream The skimmed milk is coagulated in a warm place To determine its perfect coagulation, a portion of the fluid separated from caseine, is treated with hydrochloric acid, if a precipitate results there is still caseine in solution and about half a per cent of hydrochloric acid is added to the entire quantity of coagulated milk After coagulation the thoroughly whipped mass is transferred to a paper filter the fluid allowed to drain off thoroughly and the caseine remaining on the filter washed with rainwater until the water running off no longer displays a trace of free acid To remove the last residue of fat boil the drained caseine which has been tied up in a cloth in water, spread it on blotting paper and allow it to dry in a warm place when it will shrivel up into a horny mass

Thickening for Mineral Lubricating Oils—According to Marquardt aluminium sebate makes a thickening for mineral lubricating oils A 10 per cent solution of this substance in mineral lubricating oil produces a brown, tolerably consistent mass, capable of being drawn out in threads and difficult of fusion, and known in commerce by the name of "liquid gelatine though containing no trace of gelatine It causes the mineral oil to froth when used and clogs the parts of the machine by setting free the alumina soap, especially when water is present If such mineral oil is shaken up with 95 per cent alcohol and ether carefully added to it the aluminium sebate is precipitated, first in flakes and then in lumps, but it is redissolved in an excess The ash content of pure mineral oil does not exceed 0 058 per cent, soda lye does not eliminate the alumina completely but the exact quantity eliminated can be accurately determined by the following process; If heated in a water bath with constant stirring diluted hydrochloric acid will remove all the alumina, soda lye will then absorb the fatty acids from the separated mineral oil, and these fatty acids can in their turn be precipitated with a mineral acid and their weight determined The difference between the weight of a mineral oil eliminated from the alkaline solution by means of a separating funnel and the original weight is equivalent to the quantity of fatty acid anhydrides and alumina found

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Alcohol
Its Manufacture
Its Denaturization
Its Industrial Use

The Cost of Manufacturing Denaturized Alcohol in Germany and German Methods of Denaturation are discussed by Consul General Frank H Mason in SCIENTIFIC AMERICAN SUPPLEMENT 1550

The Use, Cost and Efficiency of Alcohol as a Fuel for Gas Engines are ably explained by H Diederichs in SCIENTIFIC AMERICAN SUPPLEMENT 1596 Many clear diagrams accompany the text The article considers the fuel value and physical properties of alcohol and gives details of the alcohol engine wherever they may be different from those of a gasoline or crude oil motor

In SCIENTIFIC AMERICAN SUPPLEMENT 1581 the **Production of Industrial Alcohol and Its Use in Explosive Motors** are treated at length valuable statistics being given of the cost of manufacturing alcohol from farm products and using it in engines

French Methods of Denaturation constitute the subject of a good article published in SCIENTIFIC AMERICAN SUPPLEMENT 1599

How Industrial Alcohol Is Made and Used is told very fully and clearly in No 8, Vol 95 of SCIENTIFIC AMERICAN

The Most Complete Treatise on the **Modern Manufacture of Alcohol,** explaining thoroughly the chemical principles which underlie the process without too many wearisome technical phrases and describing and illustrating all the apparatus required in an alcohol plant is published in SCIENTIFIC AMERICAN SUPPLEMENTS 1603, 1604 and 1605 The article is by L Baudry de Saunier the well known French authority

In SUPPLEMENTS 1607 1608 1609 we publish **a digest of the rules and regulations** under which the U S Internal Revenue will permit the manufacture and denaturation of tax free alcohol

A Comparison of the **Use of Alcohol and Gasoline in Farm Engines** is given in SCIENTIFIC AMERICAN SUPPLEMENTS 1634 and 1635 by Prof Charles E Lucke and S M Woodward

The Manufacture, Denaturing and the Technical and Chemical Utilization of Alcohol is ably discussed in the SCIENTIFIC AMERICAN SUPPLEMENTS 1618 and 1636 by M Klar and F H Meyer both experts in the chemistry and distillation of alcohol Illustrations of stills and plants accompany the text.

The Source of Industrial Alcohol, that is the Farm Products from which alcohol is distilled are enumerated by Dr H W Wiley in SCIENTIFIC AMERICAN SUPPLEMENTS 1611 and 1613 and their relative alcohol content compared

The Distillation and Rectification of Alcohol is the title of a splendid article by the late Max Maercker (the greatest authority on alcohol) published in SCIENTIFIC AMERICAN SUPPLEMENTS 1627 and 1628 Diagrams of the various types of stills in common use are used as illustrations

In SCIENTIFIC AMERICAN SUPPLEMENT 1613 the **Uses of Industrial Alcohol in the Arts and in the Home are discussed.**

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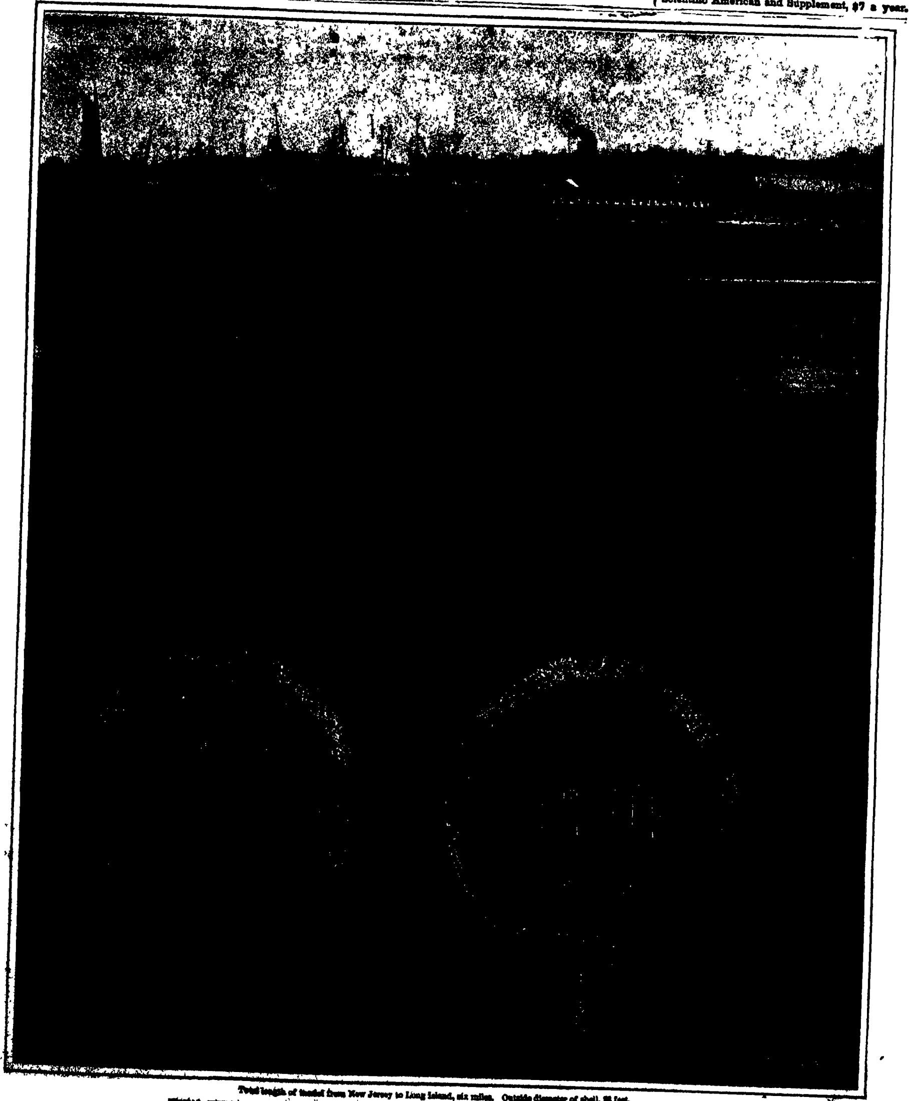


Total length of tunnel from New Jersey to Long Island, six miles. Outside diameter of shell, 23 feet.

[illegible] VIEW OF PENNSYLVANIA RAILROAD TUNNEL NOW UNDER CONSTRUCTION BENEATH THE HUDSON RIVER.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

This issue of the SCIENTIFIC AMERICAN SUPPLEMENT is intended to describe briefly what is known as the New York Tunnel Extension of the Pennsylvania Railroad the costliest improvement ever made by a railroad company and one of the most far reaching importance to industry and to the traveler

The New York Tunnel Extension of the Pennsylvania Railroad begins at Harrison N J a few hundred yards east of Newark N J It is at this point that through passenger trains from southern and western points are to change their steam power for electricity At Harrison there are transfer platforms for passengers a car yard and a yard for the huge electric locomotives used in the tunnels

Through trains for New York leave Harrison on rails crossing over the old Pennsylvania tracks on a tremendous concrete bridge A double track line on a high embankment extends across the marshy Hackensack Meadows to Bergen Hill that high eminence which is a continuation of the rocky cliffs extending along the Hudson River At this hill are found the entrances to the tunnels which lead under the North River into the station in New York and then on to Long Island City

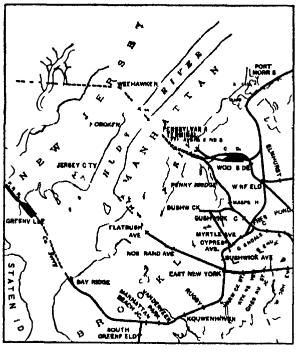
Before going on to New York on the new line running northeast from Harrison a short trip over to Newark on the proposed electric line running to Park Place Station shows the facilities which the Pennsylvania is providing for rapid transit service between Newark and New York Electric trains are to run from Park Place Station in Newark to Harrison and from there over an electrified line to Jersey City Track connections will be made with the Hudson and Manhattan Railroad so that the Newark trains will run direct to the Hudson Terminal at Cortlandt and Church Streets in the lower part of New York city Later it may be found desirable to run some of the Newark electric trains into the New York Station at Thirty third Street by way of Harrison

THE PENNSYLVANIA STATION

The Pennsylvania Station in New York city is most advantageously situated the main entrance being on Seventh Avenue between Thirty first and Thirty third Streets The tracks are 40 feet below the street surface and the station is divided into three levels The Seventh Avenue entrance is for foot passengers only It leads to the main waiting room through an arcade 22[illegible] feet long by 4[illegible] feet wide flanked on both sides by shops and booths At the farther end of the arcade are the restaurant lunch rooms and café and beyond is the general waiting room and concourse

On the first level below the street is the station proper Here is the general waiting room the largest in the world 277 by 103 feet Within its walls are located the ticket offices and baggage checking windows all so arranged that a passenger may proceed from one to the other with a minimum amount of exertion and without retracing his steps Adjoining the general waiting room on the west are two subsidiary waiting rooms 58 by 100 feet for men and women provided with seats and opening into retiring rooms

On the same level with the general waiting room the main baggage room with 450 feet of frontage is located This is for the use of the transfer wagons and covers the full area occupied by the arcade and restaurants on the plane above Baggage is delivered and taken away through a special subway From the baggage room trunks are delivered to the tracks below by motor trucks and elevators Motor cabs will also be stationed on this level



MAP OF PENNSYLVANIA RAILROAD SYSTEM IN VICINITY OF NEW YORK

Parallel to and connecting with the main waiting room by a wide thoroughfare is the concourse a covered assembling place over 200 feet wide extending the entire width of the station and under the adjoining streets An idea of the width of this concourse is gained by a comparison of it with the lobby of the Jersey City train shed which is narrower by twenty five feet This is the vestibule to the tracks stairs descend from it to each of the train platforms on the track level The concourse and adjacent areas are open to the tracks forming a courtyard 340 feet wide by 210 feet broad roofed by a lofty train shed of iron and glass In addition to the entrances to the concourse from the waiting room there are also direct approaches from the streets

Auxiliary to the main concourse and located between it and the tracks is a sub concourse sixty feet wide which will be used for exit purposes only This exit concourse is eighteen feet above the tracks but is connected with the track level by two stairways and one elevator from each platform From it ample staircases and inclines lead directly to the street.

The northern side of the station extending along Thirty third Street is assigned to the Long Island Railroad Into this part of the station trains will run from all points on Long Island by way of the East River tunnels Ample entrances and exits are provided so that this traffic can be handled independently

The third level for the passenger is the train platform about thirty six feet below the surface of the street This level is so gradually reached that the descent is scarcely noticeable

The stone work of the station inclosing some eight acres of ground was completed on July 31st 1909 To inclose this vast area has necessitated the building of exterior walls aggregating 2458 feet—nearly half a mile in length and has required 490 000 cubic feet of pink granite In addition there have been utilized inside the concourse 60 000 cubic feet of stone A total of [illegible]0 000 cubic feet of granite has thus been utilized in the construction and ornamentation of this building It took 1 140 freight cars to transport these 47 000 tons of stone from Milford Mass

In addition to the granite the construction of this building has called for the use of 27 000 tons of steel There have also been set in place some 15 000 000 bricks weighing a total of 48 000 tons The first stone of the masonry work on the building was laid June 15th 1908 the entire masonry was thus completed in approximately thirteen months after the work was begun

Built after the Roman Doric style of architecture the building covers the entire area bounded by Seventh and Eighth Avenues and Thirty first and Thirty third Streets The depth of the property on both streets is 799 feet 11¼ inches and the length of the building is 788 feet 9 inches thus allowing for extra wide sidewalks on both avenues The walls extend for 430 feet 6 inches from Thirty first Street to Thirty third Street the Seventh Avenue façade signalizing the main entrance

In designing the exterior of the building Messrs McKim Mead & White the architects were at pains to embody two ideas To express in so far as was practicable with the unusual condition of tracks far below the street surface and in spite of the absence of the conventional train shed the exterior design of a great railway station in a generally accepted form and also to give to the building the character of a monumental gateway and entrance to a great metropolis

Apart from those two ideas the plan of the station was designed to give the greatest number of lines of circulation The structure is really a monumental bridge over the tracks with entrances to the streets on the main axes and on all four sides In this respect this building is unique among the railroad stations of the world, affording the maximum amount of entrance and exit facilities possible

The Seventh Avenue façade is composed principally of a Roman Doric colonnade, double at the carriage entrances at the street ends and at the main front entrance for pedestrians in the center, each of the columns being 4 feet 6 inches in diameter and 35 feet high. Above the central colonnade is an entable-

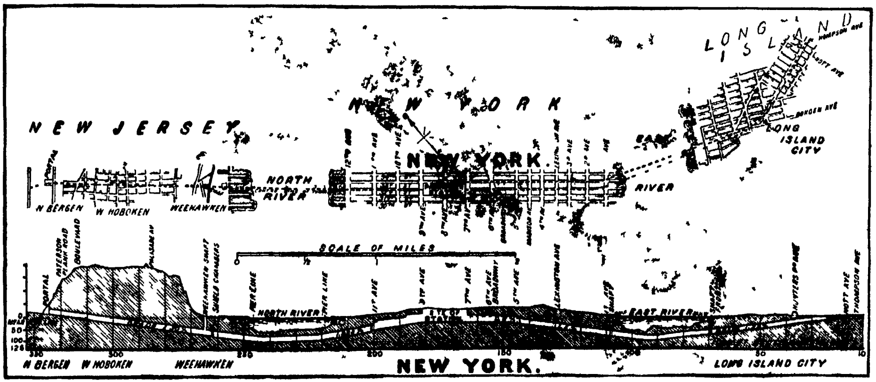
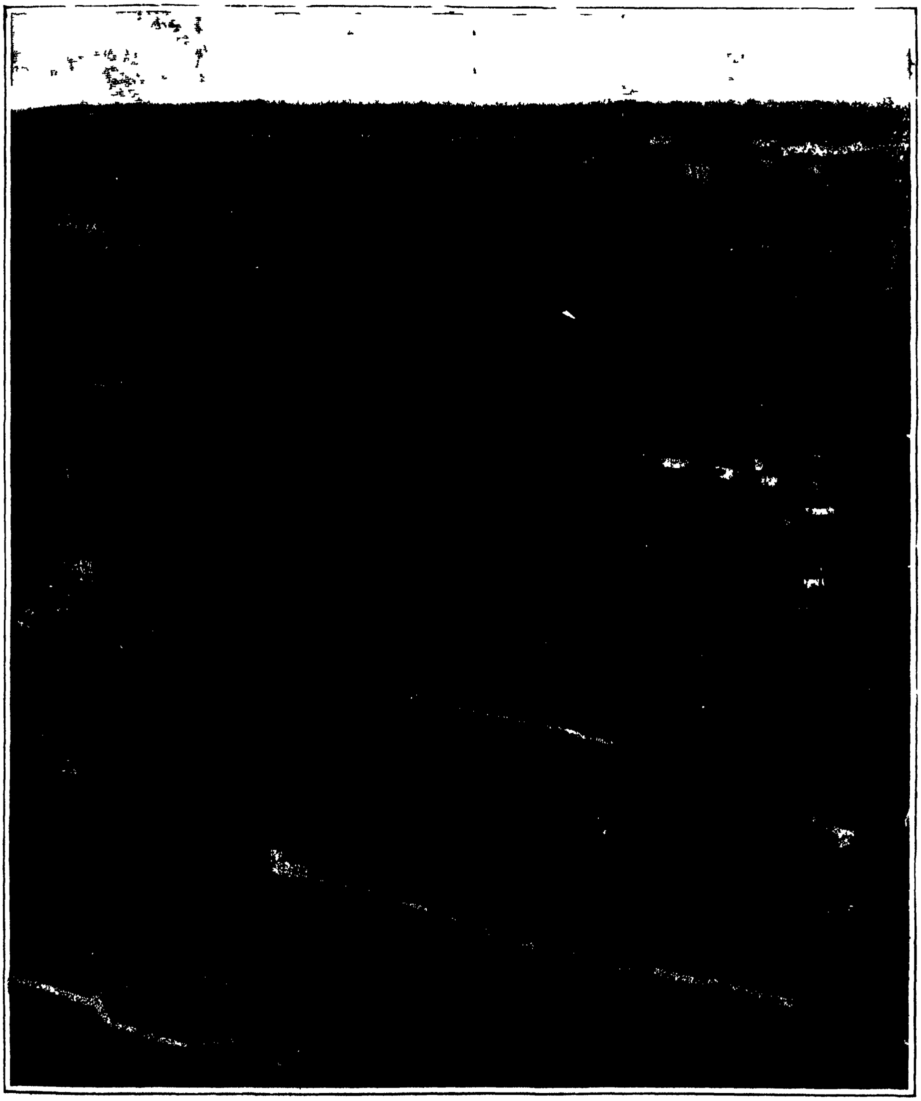


DIAGRAM SHOWING THE LINE OF THE PENNSYLVANIA TUNNELS UNDER THE HUDSON AND EAST RIVERS.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.



Bird's eye view showing the vast area, 2,050 feet by 500 feet, which was excavated to a depth of 80 feet, necessitating the removal of 2,000,000 cubic yards of material.

ACRES OF VALUABLE LAND IN THE HEART OF NEW YORK LAID WASTE FOR THE NEW PENNSYLVANIA RAILROAD STATION

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK

ture surmounted by a clock with a dial 7 feet in diameter. The center of this clock is on the axial line of Thirty second Street and 61 feet above the sidewalk.

This Seventh Avenue façade was conceived especially to express in largest possible fashion a monumental gateway. It may be compared in a greatly magnified manner to the Brandenburg Gate in Berlin through which passes so much of the traffic of that city.

The main body of the building approximates in height the Bourse of Paris, reaching 76 feet above the street level. With entrances through each of the two corners of the station on Seventh Avenue there are carriage drives, each about 63 feet wide, or the width of a standard New York city street, fronted by double columns and pediments. The frontages on Thirty first and Thirty third Streets are similar. The walls of the exterior of the carriage drives are of pilaster treatment for a distance of some 279 feet.

Midway along the sides of the building signalizing the entrances on Thirty first and Thirty third Streets are series of columns of the same dimensions as those on the Seventh and Eighth Avenue façades for a distance of 117 feet. Above these colonnades are also sculptured groups supporting large ornamental clocks. For 116 feet beyond there are interrupted colonnades after which the walls are of pilaster treatment to Eighth Avenue with the exception of 45-foot colonnades marking entrances to the concourse.

The Eighth Avenue frontage is treated on the plan of pilasters except for [illegible] feet [illegible] inches which is broken by columns in [illegible] of three spaces to mark another spacious entrance to the main floor of the concourse.

One of the distinctive features of this building is the waiting room which extends from Thirty first to Thirty third Streets, its walls parallel to Seventh and Eighth Avenues for a distance of 314 feet 4 inches. The height of this room is 150 feet and its width 108 feet 8 inches. The walls of the waiting room above the main body of the building contain on each side three semi-circular windows of a radius of 33 feet

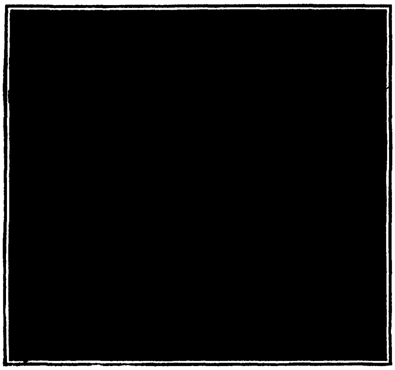
4 inches or 116 feet 8 inches wide at the base. There is also a window of like size at each end of the waiting room.

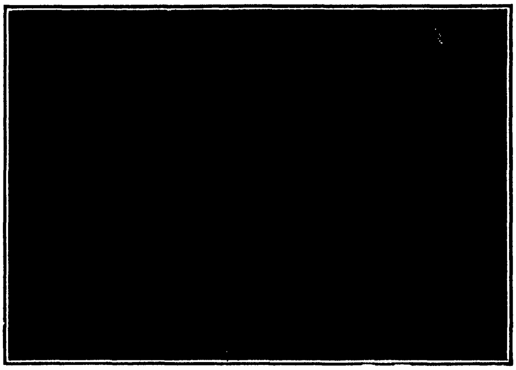
The dignified design of the interior of the general waiting room, while fully adapted to modern ideas, was suggested by the great halls and basilicas of Rome, such as the baths of Caracalla, Titus and Diocletian, and the basilica of Constantine, which are perhaps the greatest examples in history of large roofed-in areas treated in a monumental manner.

While the façades of the station were intended to suggest the imposing character of these ancient Roman temples and baths, the impression intended to be made upon the layman approaching the station in full view of the exterior of the general waiting room with its huge semi-circular windows is that of one of the leading railway stations of the world.

In addition to this description of the architectural features of the station and of its interior arrangement, these statistics have been supplied by the engineers who had charge of the construction of the New York Tunnel Extension:

Area (Tenth Avenue to normal tunnel section east of Seventh Avenue)	28 acres
Length of trackage	16 miles
Number of standing tracks at station	21
Length of platforms adjacent to passenger trains	21,500 feet
Number of passenger platforms	11
Highest point of tracks—below sea level (M. H. W.)	9 feet
Number of baggage and express lifts	25
Length of baggage express trucking and pipe subways	5 200 feet
Weight of street bridging steel	23,500 tons
Weight of station building steel	27,000 tons
Weight of steel in service building .	2,437 tons
Total excavation required	3 000 000 cu yds
Length of retaining walls	7 800 feet
Number of lineal feet of streets and avenues carried on bridging	4 400 or an area of about 8 acres
Dimensions of passenger station building 784 feet long 430 feet wide average height above street 69 feet maximum height above street 153 feet	
Dimensions of main waiting room 277 feet long, 103 feet wide 150 feet high	
Dimensions of concourse 340 feet long, 210 feet wide	
Concrete required for retaining walls foundations street bridging and sub-structures	160,000 cu. yds
Loading per square foot on avenue bridging	1½ tons

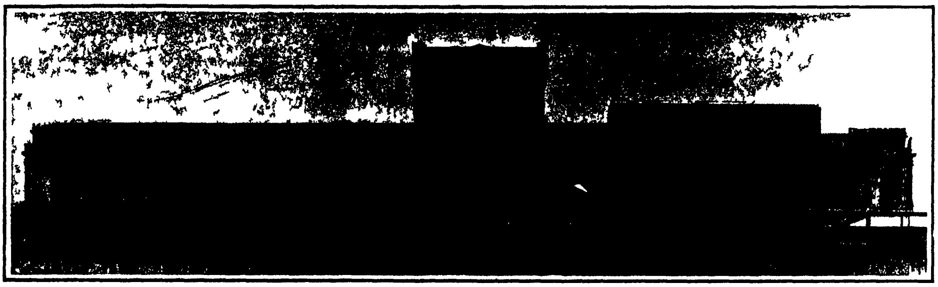

FRONT VIEW OF THE SHIELD USED IN THE PENNSYLVANIA TUNNEL


TAIL OF A PENNSYLVANIA SHIELD SHOWING A PORTION OF TUNNEL LINING TEMPORARILY ERECTED

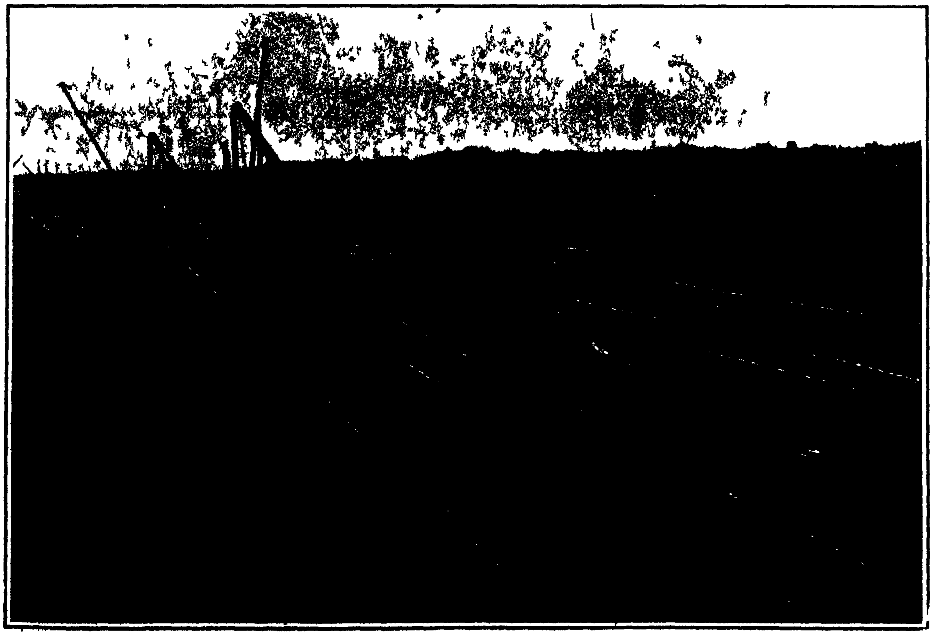
This view shows the point where C tunnel crosses over B near the Long Island portal.

VIEW LOOKING WEST AT PENNSYLVANIA RAILROAD TUNNELS AS THEY NEAR THE SURFACE IN LONG ISLAND CITY

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK



SECTIONAL VIEW OF THE STATION ON A LINE RUNNING EAST AND WEST



On the left is seen the brick-covered concrete top of one completed tunnel dotted lines show position of completed portions of the other two [illegible] to those shown in course of construction [illegible]

VIEW LOOKING EAST FROM THE SAME POINT SUNNYSIDE YARD IN THE DISTANCE

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK

Maximum loading per square foot on bridging east of Seventh Avenue	5 tons	
Number of columns supporting station building	650	
Greatest weight on one column	1 658 tons	
Number of buildings removed on terminal area—about	500	
Dimensions of service power plant in Thirty first Street	160 feet x 100 feet	
Boiler capacity of service power plant (ultimate)	5 000 H P	
Number of electric lights in terms of 16 candle power lamps and inclosed arc lamps in passenger station building Arc 532 incandescent 21 951 about	30 000	
Maximum capacity of all tunnels in trains per hour		144
Storage capacity of station yard tracks		386 cars
Proposed initial daily service of P. R. R. trains	400	
Proposed initial daily service of L. I. R. R. trains	600	1 000 trains
Length of river (tube) tunnels (single track miles)	6 8 miles	
Length of land tunnels (single track miles)	6 8 miles	
Length of run Bergen Portal to Long Island Portal	5 3 miles	
Total length of track in tunnels exclusive of yard tracks in station	16 5 miles	
Length of run Harrison to Terminal Station	8 6 miles	
Length of run Jamaica to Terminal Station	11 85 miles	

When the two tracks emerge from the tubes under the Hudson and reach the entrance to the station yards at Tenth Avenue they begin to spread out From Ninth Avenue and extending into the station the number grows from two to twenty-one There is a reduction in the number of tracks leading out of the station yard to the east to a total of four for the main line passing under the city and thence under the East River to the Sunnyside Yard on Long Island

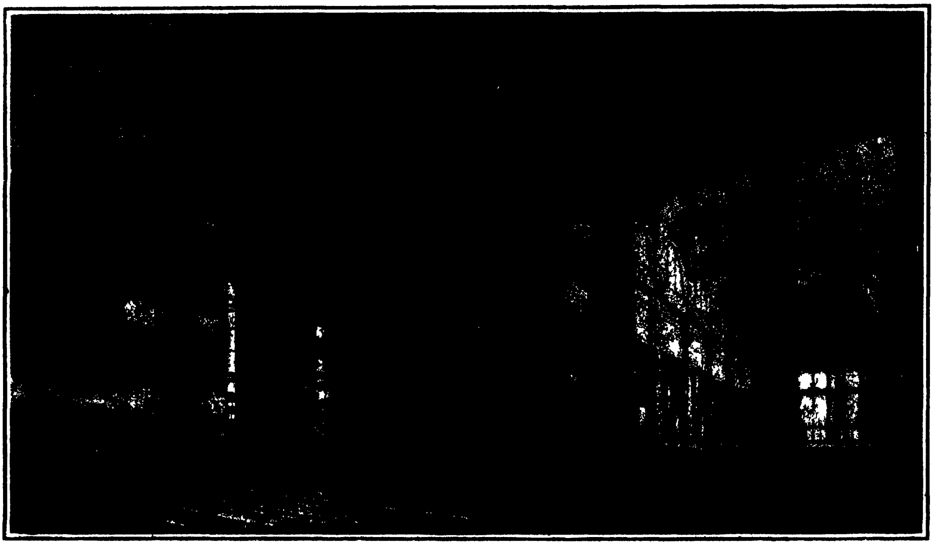
From the station twin tunnels giving four tracks in all traverse a section of New York city second in importance only to the financial district and one that includes the larger hotels retail shops and theaters and many residences The Manhattan Crosstown Tunnels end at the river shaft is situated in the block between Thirty-third and Thirty-fourth Streets [illegible] of First Avenue From this [illegible] the under-river tubes four in number extend under the East River to Long Island City and Sunnyside Yard the terminus of the tunnel extension

Sunnyside Yard is to the New York improvement what the West Philadelphia [illegible] yard is to the Philadelphia terminal [illegible] the Jersey City station [illegible] features such as the [illegible] trains around a loop [illegible] cleaning yard at one [illegible] end thus turning the [illegible] necessity for switching [illegible] cars and [illegible] cars to opposite ends of the trains and the [illegible] of combination cars separately The arrangement [illegible] tracks on different levels makes provision for [illegible] ments without grade crossings and [illegible] ference with high speed traffic

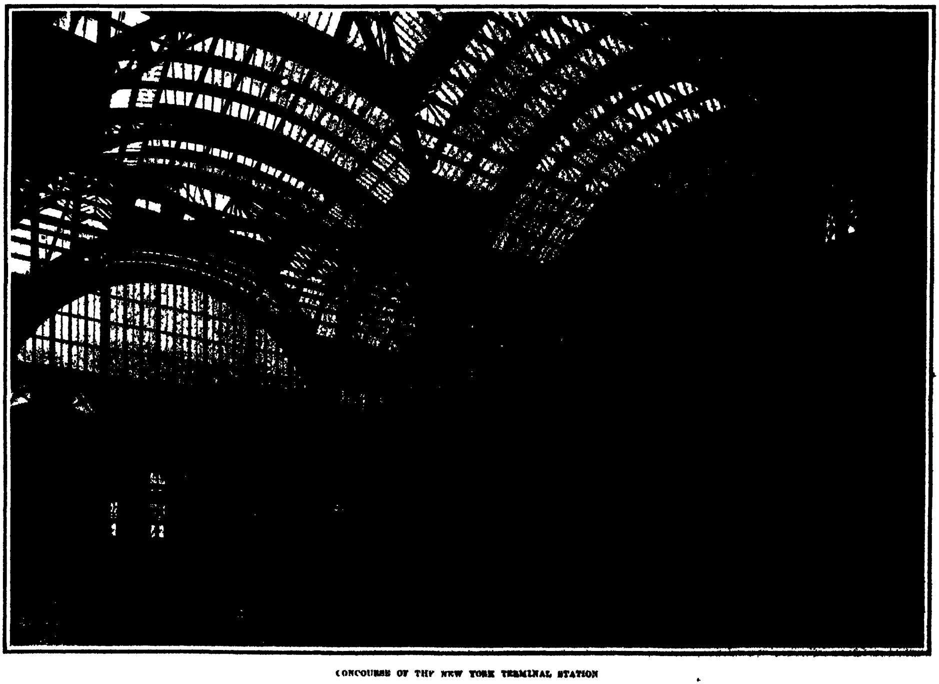
Sunnyside Yard is 5 500 feet long and [illegible] wide embracing some 153 acres of land [illegible] 7 miles of track which have a capacity of [illegible] There is additional space for extending the [illegible] tracks of the yard to provide for [illegible] whenever it is required

From Sunnyside Yard there are tracks leading to the New York Connecting Railroad the lines of which will form a junction with the New York New Haven & Hartford Railroad at Port Morris New York The Connecting Railroad will cross the East River by the Hell Gate Bridge over Ward's and Randall's Islands

In connection with its improvement in and around New York city the Pennsylvania Railroad Company has constructed at Greenville N J an extensive freight transfer yard It is also the most completely equipped yard for the rapid and economic handling of freight From Greenville the cars are transported by floats and delivered to the great piers of the city Freight destined to Brooklyn or to other points on Long Island is floated across the bay from Greenville to Bay Ridge on the opposite shore of Long Island Freight for New England and eastern points is floated up the East River to the New York New Haven & Hartford Railroad's Port Morris station Later when the New York Connecting Railroad is constructed freight will be floated to Bay Ridge and run over Long Island tracks to the Connecting Railroad and thence to the mainland where connection is made with the New York New Haven & Hartford Railroad system for Boston and New England points



CORNER OF LOGGIA IN THE NEW YORK TERMINAL STATION



CONCOURSE OF THE NEW YORK TERMINAL STATION

[illegible]

One of the most important features of the Pennsylvania Railroad's New York Tunnel Extension is its relation to the Long Island Railroad—a subsidiary line of the Pennsylvania and the only other road that will operate trains into the New York passenger station.

It is estimated that forty minutes will be saved between Long Island points and New York city by the operation of trains through the East River tunnels into the Pennsylvania station at Thirty-third Street and Seventh Avenue.

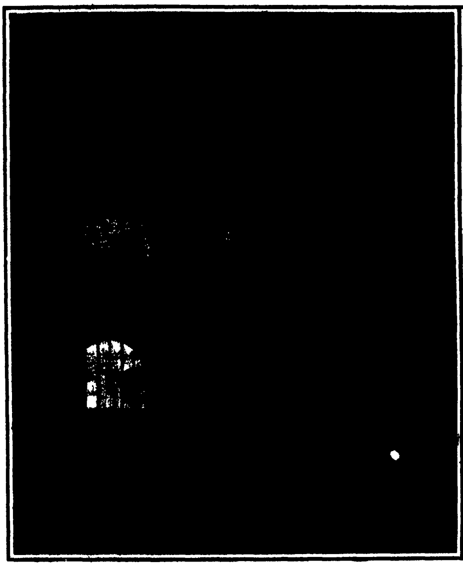
In addition to the many millions the Pennsylvania Railroad has spent and is spending for the four tunnels under the East River and the vast station and terminal in Manhattan by which all Long Island will benefit, the Long Island Railroad is increasing its own facilities in all directions to take care of the present large traffic and the larger traffic which will come upon the completion of the tunnels. To accomplish this will necessitate an expenditure on the part of the Long Island Railroad of more than thirty million dollars.

The population included within a circle of 19 miles radius with City Hall, Manhattan, as the center, in 1890 was 3 326 998; in 1900 it was 4 012 153, and five years later it was 5 404 638, an increase in ten years of 38 per cent. In 1913 it is estimated that the population of this territory will approximate six million people, and in 1920 eight million people.

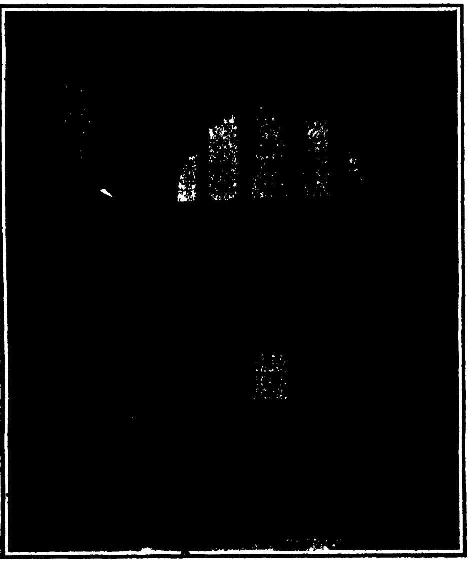
Railroads on the western bank of the Hudson River opposite New York city carried in 1886 nearly 59 000 000 people. In 1890 they carried over 72 000 000; in 1896 more than 94 000 000, and in 1906 about 140 000 000 people.

These startling figures were considered when the Pennsylvania Railroad was contemplating entering New York city. It was evident that one of the greatest transportation problems in history was rapidly evolving, and it was only by quick action that the railroads could prepare facilities to cope with it.

With the traffic in and out of New York city growing as it has grown in the past twenty years, the situation confronting the management of the railroad was whether the quantity of this traffic was such as to warrant any other method of transportation than ferries for crossing the North and East Rivers and



ARCADE ENTRANCE TO LOGGIA



WAITING ROOM—DETAIL TO 33RD STREET SIDE

WAITING ROOM IN THE NEW YORK TERMINAL STATION

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

stifling competition has put additional life into it, and we have already reached in this country a displacement of [illegible],000 tons, while in America battleships of [illegible],000 tons are in contemplation. The situation is analogous to the wars of rates which occasionally disturb the commercial world, and which, if they do not ruin one or more of the competitors, are only ended by an agreement to limit prices. It is too much to expect, in view of the nonsuccess of efforts in this direction in the past, that any agreement is possible toward limitation of armaments either in respect to size of vessel or numbers.

DRIVEWAY OF THE TERMINAL STATION

ARCADE OF THE STATION

LUNCHEON ROOM

THE RESTAURANT ROOM

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK

We turn to the other feature of the Dreadnought design, and here, as Sir William White remarked, it is astonishing that every considerable naval power except ourselves remains convinced as to the value of a powerful secondary armament. A distinction must be drawn between the smaller guns, such as the 12-pounder or 4-inch, which are only expected to be of [illegible] against torpedo attack, and the secondary armament proper, which, strictly speaking, should embrace any guns of caliber between the main armament and the 4-inch weapon. Some people indeed consider the 6-inch as an ideal antitorpedo gun, though it would be almost as accurate to describe a sledge hammer as the ideal instrument for cracking nuts. Torpedo attacks are not made in the open when the vessel attacked has time to train her guns on the torpedo boat or destroyer, unless it is at the end of an engagement against a practically disabled ship. They are made under cover of darkness or some other favorable screen, and to be effective the attack must be sudden and unexpected. To meet such an attack under these conditions volume and rapidity of fire rather than strength of individual hits is essential, for it is fairly certain that much of the shooting will, even with the best trained gunners, be wide of the mark under such adverse conditions. The number of guns mounted for this purpose is therefore more important than their size, provided they be of such caliber that a single shot can disable the adversary. A single 12-pounder shell will wreck a destroyer's engine room, and a 4-inch shell accurately placed between wind and water would in all probability sink her. As the effective range of the torpedo is increased, the size of the antitorpedo gun must go up also, so as to be equally effective against destroyers at the longer ranges, but it is easy to see that the smaller the gun which is suitable for the work, the greater will be the number of positions which can be found for mounting it in a vessel of given dimensions. These are considerations more or less outside the range of controversy, but the efficacy and the desirability of mounting guns intermediate in size between the antitorpedo and the main armament is a question on which opinion is very sharply divided in this country, though, as we have stated, other navies seem to entertain no doubts at all on the subject. The reasons which Admiral Bacon gives against the secondary armament are two in number. The first is that these guns tend to reduce the accuracy of fire of the heavier guns, and the second that the weight and therefore the extra tonnage that the installation demands could be better devoted to other purposes. He also stated that they could not be mounted without restricting the fire of the heavy guns, but this argument was demolished by Sir William, who pointed out that in some American ships eight large guns had been employed with a powerful secondary armament free from the defect which Admiral Bacon said must accompany it. As to the question of fire control, it does not require an expert to appreciate Admiral Bacon's point as to the difficulty of correcting the fire of different calibers of guns with varying rapidity of fire and varying external ballistics. The matter is no doubt of importance with respect to gunnery returns and target practice, but the point is what exactly will be the extent of their disability under real conditions. The experiments carried out against the old battleship "Hero" are reported to have shown that fire control stations are not likely to survive after the first few minutes of an engagement, and if this is the case firing would become independent, and each gun's crew would have to rely upon its own judgment. Under such conditions some accuracy of fire due to the absence of fire control would be lost, but it does not appear likely that any one gun would interfere with another's accuracy.

No one can read the absorbing narrative by Captain Semenoff of the battle of Tsu Shima without being struck by the undoubted havoc which the 6-inch guns of the Japanese vessels caused, and the fact that since the war the Japanese themselves have laid down battleships with powerful secondary armaments shows that they appreciated the part which these guns played. Admiral Bacon, in his reply, endeavored to discount the lesson of Tsu Shima by the arguments that this battle was fought with old type ships, and that gunnery had enormously improved since that date. From a less powerful advocate than Admiral Bacon these arguments would appear entirely inconclusive. We must assume equality of type of ship on either side, and what was true of battleships of the "Royal Sovereign" and "Majestic" era should be true *mutatis mutandis* of vessels of the "Dreadnought" era. The argument based on improvement of gunnery also has little weight unless we assume that the fire control remains undamaged, and so gives the single-caliber ship the advantage. Another point, which escaped notice at the meeting, is the fact that larger guns have a much shorter life than the smaller. The longer a decisive action is deferred in a naval war the more important relatively becomes the secondary armament, as the big guns become badly worn and accuracy of shooting falls off more rapidly than in the case of the smaller guns This point is brought out in Captain Semenoff's book and no doubt in a measure accounts for the large proportionate effect produced by the Japanese 6-inch guns The question of secondary armament is as Sir William said a vital one, and in view of the decided course taken by other navies should be carefully reconsidered —The Engineer

SIR J. J. THOMSON ON GOLF BALLS

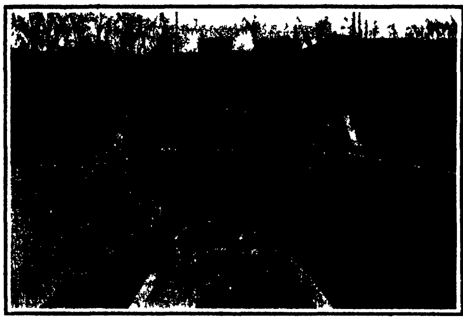
In a recent lecture at the Royal Institution Sir J J Thomson discussed the Dynamics of a Golf Ball in which he said that various explanations of the behavior of golf balls had been put forward and if all of these were sound his lecture should be exceptionally interesting for he would have to enunciate a new theory of dynamics It sometimes seemed that the better the golfer the worse his dynamics If the converse were the case every confidence might be felt in the results he had to bring forward If the ball was in the exceptional position of having no spin it moved forward without deviating to the right or the left If it had spin its course was more erratic, yet its movements were the result of a commonplace and prosaic law, which was its only secret so far as the broad effects were concerned— he would not say the minutiæ —that it always tried to follow its own nose Practically the complete explanation was given by Newton who pointed out that the pressure was greatest on that side of a tennis ball at which the forward and the rotary motions conspired together, hence the reaction of the air was greater on that side and the ball was pushed in the direction in which it followed its own nose

To demonstrate this difference of pressure the lecturer showed an experiment which consisted in placing two tubes, connected to a manometer, at opposite sides of a cylinder rotating in the blast from a blower By employing golf balls in place of the cylinder he was also able to show the effects of smooth and rough surfaces the difference of pressure with the latter being distinctly the larger A ball with underspin tended to rise according to the law and if its speed of travel and speed of rotation were both considerable it might pursue a course doubling on itself in a loop though such a phenomenon might not be commonly observed on a golf links The production of a path with a kink in it would be facilitated by using a light ball and with the aid of a gas balloon in which the weight was largely reduced the effects of spin in producing paths of this kind could be readily exhibited

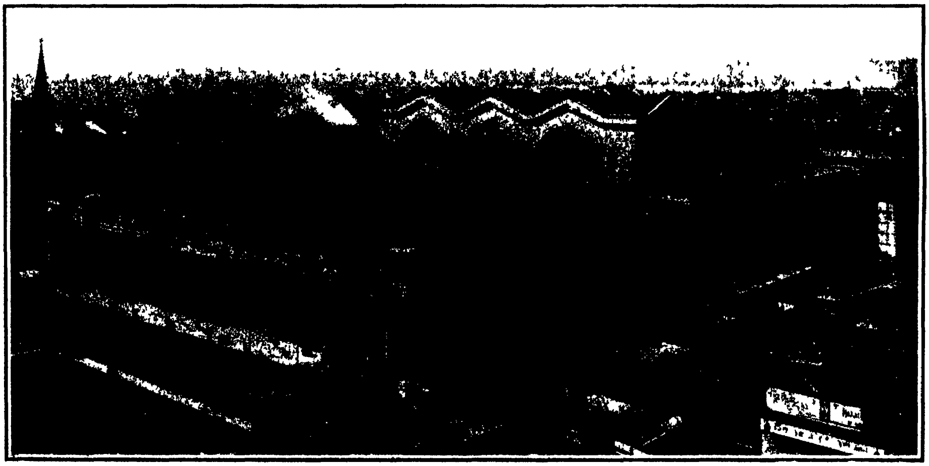
After explaining why the effects of slicing and pulling manifested themselves most strongly toward the end of the flight as was a matter of common experience the lecturer applied his laws to the question How a player should proceed in order to get a long carry in a cross wind? If the wind were from left to right, then the point of pressure would be behind the sliced ball and slicing would help its flight On the other hand, the pressure would be in the front of a pulled ball which in consequence would be retarded Hence theory indicated that to get a long carry in a cross wind from left to right the ball should be driven into the wind but slightly sliced His own control over his club was not sufficiently certain to enable him to test this rule, but some of his friends had found it to be sound Finally using what he described as an electric golf links he showed the analogy between the behavior of the cathode rays in a vacuum tube and the flight of a golf ball the spin round any axis being imparted to the electrified particles by means of a magnet By way of moral he pointed out that much science was connected with golf, cricket, and other games and he thought it was a pity that the enthusiasm of English boys for games merely as games was not utilized in order to rouse in them an interest in scientific matters —English Mechanic and World of Science

SOME CURIOUS PHASES OF CHINESE JOURNALISM

The Celestial Empire which is the real cradle of our journalism and whose oldest newspaper the Peking Gazette celebrated its one thousandth anniversary a short time ago was opened only quite recently to modern journalism In a late number of the Revue the mandarin Ly Chao Pe gossips about the many curious results of the sudden acquaintance of the wearers of the queue with the modes of the present periodical press It must not be supposed that the Chinese regard the newspaper with faltering attention rather they show the liveliest interest for all political events and news One need only to visit one of the numerous little tea houses to discover the insatiable desire for gossip that resides in the Sons of the Middle Kingdom The women too share this curiosity with unmistakable insistence and the laundries everywhere in the Empire precisely as in the West are a veritable living newspaper The newspapers which have been developed since the year 1900 and are issued for the great bulk of the population are published in a most various manner Some of them make cursory mention of almost everything so to speak others devote themselves especially to trade agriculture science or religion A satirical press is also in very keen vogue swarms with merry caricatures that illumine the caustic criticism with which it describes the conduct of the government and with merciless candor pictures the daily life of the individual official prods


ENTRANCE TO NORTH RIVER TUNNELS BERGEN HILL N J

SUNNYSIDE YARD ENTRANCE TO TUNNELS LEADING UNDER EAST RIVER


A GENERAL VIEW OF THE PENNSYLVANIA RAILROAD TERMINAL STATION IN NEW YORK CITY.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK with a tantalizing finger all kinds of applicants and candidates who are seeking to pass examination ridicules the primitive modes of traffic or any other antiquated device

As is well known there are seven different styles in Chinese literature the antique style the literary style the flowery or elegant style the ordinary style the semiliterary semiordinary style the familiar style and the epistolary style

Naturally the newspapers are written in the ordinary style and make use of the new alphabetic characters which have been substituted by the government for the old and cumbersome characters and have been learned with perfect ease by the poor classes But it does not suffice that a great list of newspapers be published the reader must understand them too and in this respect a most embarrassing gap soon showed itself For this reason societies have been formed which provide free popular lectures in towns and villages which have the sole purpose of explaining the contents of the newspapers

The common man in China has really not the faintest idea of what is meant by the preliminary parliament which the government has installed And whether popular education is benefited much by such lectures is questionable for in them one of the things for instance that recur most frequently is the explanation why the members of European parliaments attack one another with their fists and lapse so often into similar misconduct

In the meantime the government is constantly emitting new laws which regard the press It is especially anxious about the use made of old newspapers As all the characters of the native script and everything printed are consecrated to the saints of antiquity any use made of old newspapers for profane purposes would be a profound sin that would surely attract relentless misfortune It is the popular belief indeed that anyone who desecrates anything printed is sooner or later stricken with blindness Therefore to satisfy the daily need of various common wrappers and remnants a cheap thick paper of straw is made everywhere The government explicitly forbids among other things the use of newspaper to fortify the soles of sandals and shoes The intense aversion to degrading anything that is printed is best explained by the fact that a certain class of Fo-priests roam through towns villages and streets to gather with devout care every visible scrap of newspaper so that it may not be soiled by anything obnoxious All such paper is then taken before the images of the old saints and with ceremony is burned in their honor

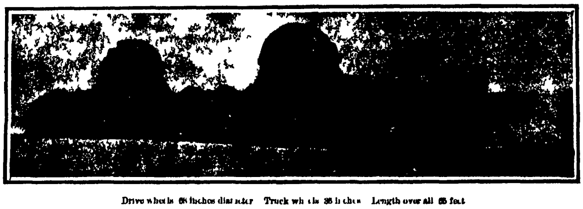
THE SYSTEM OF THE UNIVERSE

By Otto Hoffmann

Mathematicians are usually regarded as clear and sober thinkers but some of the men who have been gifted with the most marvelous power of mathematical analysis have not been free from the defects and vagaries of common mortals Newton was extremely irritable Laplace was inordinately vain Monge the inventor of descriptive geometry was very forgetful and absentminded These men however were not fanciful dreamers and few such are found among great mathematicians One of these few was Johann Heinrich Lambert the first man who endeavored to construct a system of the universe In Lambert's time a beginning of the science of celestial mechanics had been made One of his contemporaries was Laplace the author of that fundamental work the Mécanique céleste another was Lagrange and the fame of these two great men subsequently obscured that of Lambert who was the son of a tailor of Muhlhausen in Alsace Lambert's Cosmological Letters on the System of the Universe once greatly admired, are now almost completely forgotten, and this is not surprising, notwithstanding the grand conceptions which formed the basis of the work The world has moved since Lambert's time and his philosophy appears to us now one hundred and fifty years later, strange and peculiar

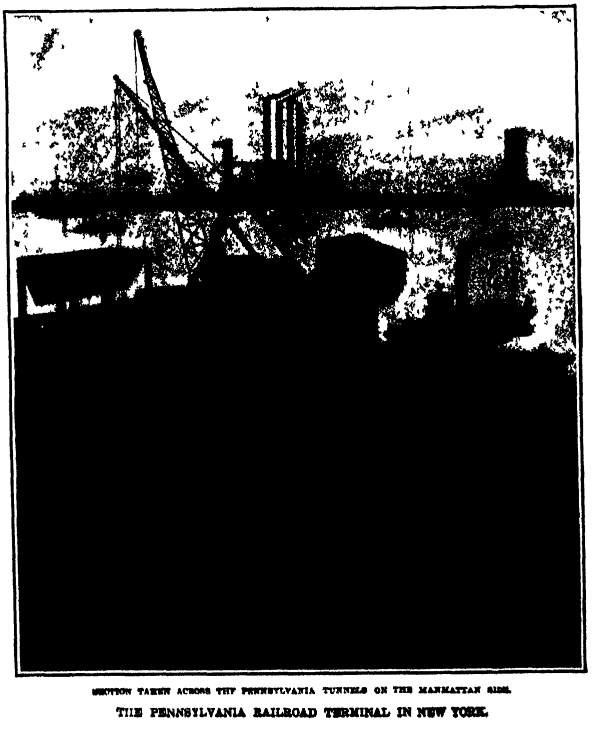
Lambert assumed that the universe was created for the purpose of being inhabited Hence it must be filled as thickly as possible with habitable bodies The sole function of the sun is to maintain life on the planets Lambert felt that the seven planets then known were inadequate for his theory and he filled space with comets asserting that there were 3 600 comets within the orbit of Saturn (As a matter of fact there are several millions) All of these comets notwithstanding the great eccentricity of their orbits which carry them from the intensely hot vicinity of the sun to the cold depths of space are, according to Lambert's theory the seat of manifold and intelligent life Lambert's exuberant fancy was not confined to the solar system As the planets with their satellites form a system of the first order the sun with its planets and comets a system of the second order Lambert assumed that systems of a third fourth and fifth order existed A system of the third order would be formed by our sun and a number of similar suns revolving round a central sun of vast dimensions A system of the fourth order would be formed by a similar combination of systems of the third order Lambert assumed the Milky Way to be such a system of the fourth order but other Milky Ways may exist, the nebulæ for example which may be combined into a system of the fifth order And so on *ad infinitum* Here Lambert entered upon ground which neither Laplace nor Lagrange had ventured to tread Both of these great men remained on the firm basis of mathematical analysis while Lambert's hypotheses are the product of an unrestrained imagination The recently deceased American astronomer Newcomb criticises poor Lambert rather too severely in asserting that Lambert's theories are entirely destitute of scientific foundation For centuries indeed it appeared as if all the labor and acumen employed in the construction of systems of the universe were necessarily wasted Within the last few years however some progress has been made in this field

We now know that there is no central sun in Lambert's sense It is very probable indeed that an accumulation of matter sufficiently vast to represent the central sun of a star cluster is physically impossible Assuming that the proportions of our solar system are repeated in such a cluster the central sun would be large enough to fill the orbit of the earth and if its density were equal to that of our sun the pressure at the center of this huge ball would be sufficient to crush the atoms themselves Sirius which Kant regarded as such a central sun and Alcyone, which Maedler assumed to represent a center of attraction are masses of the order of magnitude of our own sun It should be observed however that Maedler regarded Alcyone merely as a star situated near the center of the system, and not as a body whose attraction determines the movements of the system Such an empty center of attraction is yet unknown to us, although we know that the center of attraction may be a mathematical point instead of a body of vast mass .Lambert himself believed in a dark central sun In his time the great nebula in Orion was discovered, and Lambert regarded this nebula as a continuous body luminous only in spots Let us now examine the nature of Lambert's system with the omission of the central suns We can also safely exclude from consideration the systems of the fifth order, consisting of a number of Milky Ways revolving about a common center of attraction It is possible that other systems analogous to our Milky Way exist and revolve round each other It was once believed that certain nebulæ, which could not be resolved into separate stars by the most powerful telescope then in existence, represented such systems One of these was the nebula in Andromeda. Now, however, the prevalent view is that all the nebulæ belong to our own Milky Way, the diameter of which is estimated at



Drive wheels 68 inches diameter Truck wheels 36 inches Length over all 65 feet

CHASSIS OF THE NEW ELECTRIC LOCOMOTIVE

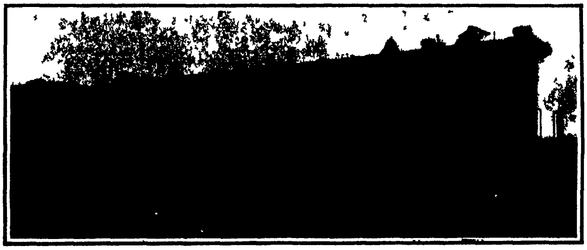


SECTION TAKEN ACROSS THE PENNSYLVANIA TUNNELS ON THE MANHATTAN SIDE.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

be 20,000 light years, a magnitude of which it is simply impossible to form any conception Gore infers from certain observations that the nearest external Milky Way must be at least so distant that its light would occupy 100 million years in coming to us Hence even if the light could penetrate the great distance between the two systems which is not certain no human eye could ever perceive a ray coming from these inconceivable distances

Hence we may confine our attention to the system of the fourth order the Milky Way which we see as a brilliant arch spanning the heavens It is generally assumed that this appearance of the Milky Way is the result of perspective and is due to the fact that we are situated near the center of the system which has the form of a double convex lens so that the stars at the edge of the lens appear more closely aggregated than the others and produce the appearance of a ring This theory was founded by Wright in the middle of the eighteenth century and it agrees with the views of Kant Lambert and Herschel but apart from the perspective origin of the apparent form of the Milky Way the investigations made by various astronomers concerning the distribution of the stars have shown that the Milky Way forms an organic whole with the myriads of fixed stars star clusters and nebulæ The density of aggregation of the stars increases with their approximation to the plane of the Milky Way but most of the nebula are found remote from this plane Those regions of the sky which are at the greatest angular distance from the plane of the Milky Way are comparatively thinly strewn with stars



Weight, 166 tons Horse power 4 000 Drawbar pull [illegible] pounds

THE NEW PENNSYLVANIA RAILROAD ELECTRIC LOCOMOTIVE

Lambert's system of the fourth order therefore, has an actual existence but notwithstanding the labors of many astronomers the laws of its motion have not yet been formulated With our present methods of observation it will never be possible to measure the parallax of the most distant stars of the system, because our base line the diameter of the earth's orbit is far too small in comparison with these vast distances The spectroscope gives us valuable information concerning the motions of the stars in the line of sight but we have a clear notion of the actual movements of only a very few stars It is a triumph of very recent years that conclusions of the greatest importance have been drawn from this scanty material

At first view the fixed stars appear to move in all directions without any regularity so that Lord Kelvin was justified in comparing the system of the Milky Way to a bubble of gas in which the molecules move with great velocity in intersecting paths in every direction On this theory the stars like the molecules of a gas move in straight lines from which they are deflected by their mutual approaches and collisions occur from time to time The stars are so sparsely disseminated however that collisions occur only about once in every 100 million million years Hence the French mathematician Poincaré regards the system as comparable with the fourth state of matter (Crookes's radiant matter) rather than with an ordinary gas On this theory it would be difficult to understand why the Milky Way preserves its lenticular form The researches of Kobold Kapteyn Schwarzschild, and others warrant the conclusion that the system is a permanent one and that the entire absence of regularity of motion which is assumed by Kelvin's hypothesis cannot represent the facts.

According to Kapteyn's "Two drift hypothesis," the proper motions of the stars so far as they are known approximately follow two opposite directions, which lead, respectively, toward the constellations of Aquila and Auriga. In other words the stars drift in opposite directions, nearly parallel to the line which connects the sun with these two constellations in the plane of the Milky Way Great swarms of stars, at immense distances from each other, pursue these common paths interpenetrate and pass each other but collisions as we have seen are extremely rare because the stars are so sparsely distributed Recent investigations by Hough and Halm of the Cape of Good Hope concerning the motions of more than

ONE OF THE 2 000 HORSE POWER MOTORS OF THE PENNSYLVANIA ELECTRIC LOCOMOTIVES

three hundred of the stars of the Southern Hemisphere in the line of sight confirm the Two drift hypothesis although there are some exceptions to the general law Our sun belongs to a cluster composed of the nearer and brighter stars all of which exhibit very similar spectra Sirius the brightest star in the heavens belongs according to the recent investigations of Hertzsprung to the system of the stars of the Great Bear which are known to be moving in parallel paths with a common velocity of 640 million kilometers or 401 million miles per year We do not know whether all these motions are related to a center or what is the real form of the course of the star drifts, but we have found some order in the apparent chaos of stellar motion The discovery of this order is the greatest result that has been achieved by astronomy in the twentieth century Lambert's fanciful system is brought a little nearer to actuality and one day perhaps the Cosmological Letters will be recalled as the first source of the idea of order in the universe—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus

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CARBON TETRACHLORIDE

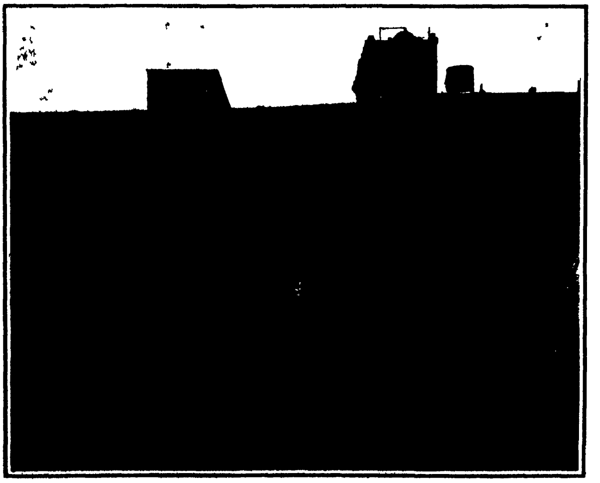
CARBON tetrachloride possesses in comparison with carbon disulphide benzine gasoline and other petroleum products used for the extraction of oils and fats the advantages of freedom from inflammability which reduces the danger of fire and the cost of insurance and of small latent heat of evaporation facility of condensation great dissolving power and lack of tendency to form emulsions with fats all of which properties effect economies in the quantity of solvent or of fuel required

Oil extracted from seeds by means of carbon tetrachloride does not retain any flavor of the solvent and the oil cake may be fed to cattle

The action of tetrachloride on metal vessels is most marked when water is present The metals least attacked are galvanized iron copper cast iron tin plate brass and sheet iron in the order given Galvanized iron should be employed in the interior of the apparatus but copper or lead pipes and bronze cocks may be used

Carbon tetrachloride is made by several processes in which carbon disulphide is acted upon by chlorine directly or indirectly The direct action takes place only at high temperatures and in presence of catalyzers In the indirect method sulphur chloride or some similar compound is employed

Cote has devised a process and an apparatus for the continuous production of carbon tetrachloride from chlorine carbon and sulphur Carbon disulphide and sulphur chloride are formed as intermediate products The apparatus resembles the continuous distilling and rectifying apparatus of modern spirit distilleries In one vertical cylinder or column which is filled with coke impregnated with manganous chloride carbon disulphide and chlorine come together and form sulphur chloride with a little carbon tetrachloride The mixture flows into a second column filled with coke impregnated with sulphide of iron where it encounters a fresh stream of carbon disulphide The resultant product consists of carbon tetrachloride mixed with a little sulphur chloride and containing free sulphur in solution This mixture passes into a third column filled with metal balls and heated to 200 deg F The carbon tetrachloride and sulphur chloride are immediately converted into vapor in which form they pass into the fourth or rectifying column while the sulphur is melted and flows into an electrically heated furnace where it combines with carbon to form carbon disul



NEW YORK PORTALS TO NORTH RIVER TUNNELS

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

phide which goes directly to the first two columns to recommence the cycle.

From the rectifying column the carbon tetrachloride passes into a vessel where it is distilled in presence of water to remove the last traces of sulphur chloride, and thence to a condensing and cooling room.

An electric furnace is employed because the process was devised especially for the utilization of the chlorine evolved in the electrolytic production of soda.

In a radically different method invented by H. S. Blackmore of Mount Vernon, U. S. A., carbon tetrachloride is produced by the action of calcium hypochlorite upon calcium carbide and hydrochloric acid. In practice a mixture of 18 parts of chloride of lime and [illegible] parts of calcium carbide is exposed to the action of a current of hydrochloric acid gas diluted with nitrogen in order to moderate the intensity of the reaction. The calcium carbide may be replaced by gaseous or vaporized hydrocarbons which should be mixed with the hydrochloric acid gas and directed upon the chloride of lime. On the other hand, the chloride of lime may be replaced by other oxidizing agents or even by oxygen provided that the operation is conducted at a dull red heat, at which hydrogen exhibits a greater affinity for oxygen than for carbon. Carbon tetrachloride is also produced by the action of the electric arc upon a fused mixture of calcium chloride and wood charcoal. The bromide, iodide and fluoride of carbon can be produced by analogous methods.

MODERN STEREOTYPY.—III.[*]

THE MECHANICS OF THE NEWSPAPER.

BY HENRY A. WISE WOOD.

Concluded from Supplement No. 1792, Page 294.

Speaking generally, the Autoplate consists of a casting mechanism and a series of finishing mechanisms which automatically co-operate in one machine to make the casts and finish them. When used to make plates of the conventional half-inch thickness its speed is four finished plates a minute, but where the thickness is but a quarter of an inch from seven to eight plates a minute are easily to be obtained. In the casting mechanism, which occupies one end of the machine, the matrix is placed. The operator by the movement of a lever starts the machine to casting, and this proceeds automatically until the desired number of plates is made and forwarded to the finishing mechanisms. Then by a reversed motion of the lever the casting mechanism is brought to rest while the matrix is exchanged for that of another page. So quickly may this exchange be made that there is lost but the time required to make one cast. Meanwhile the finishing mechanisms, which run continuously, finish and eject the remaining plates of the previous casting operation. While the machine is at work the matrix is cared for automatically; having been once inserted it requires no further attention until its full quota of plates is cast. Its controlling mechanism is so constructed that the matrix is manipulated with the utmost gentleness and precision, and as many as a hundred casts may be made from a single matrix.

From the casting mechanism the plates go automatically through various finishing operations, and when delivered are ready for the press. These operations consist of sawing off the sprue which is cast by the Autoplate machine at one of the straight edges of the plate; of sawing a narrow strip from the other straight edge of the plate; of shaving the plate's inner surface to bring the plate to accurate thickness; of accurately dressing the beveled clamping edges; and upon the latest machines, of finally bathing its inner surface to cool the plate without wetting its printing face. Thus the entire work of casting, finishing, and cooling the plate is now automatically performed at the rate of eight plates a minute by a machine which may be run by three men, whose only work consists of supplying its furnace with metal, its casting mechanism with matrices, and of removing the finished plates when ejected by the machine.

By the hand method of plate making the same amount of work could not have been done by less than [illegible] men, and even with so large a force the saving of time made possible by the Autoplate could not have been obtained, for eight matrices instead of but one would have been required.

The time saved a newspaper by means of the Autoplate machine may be divided into two parts: that which occurs in the closing of its type pages, which because of the speed of the Autoplate may now be held open longer than previously was possible; and that which occurs in starting the presses after the last page is closed. Not only may the first press of a battery be started earlier, but each succeeding press will receive its full complement of plates many minutes ahead of its former starting time. Thus a large portion of the time that each press formerly spent in waiting for plates is now utilized in producing newspapers, and a great increase of product during the first portion of a run obtained. It is apparent, therefore, that the Autoplate increases the capacity of the composing room by giving it more time in which to work, and enlarges that of the press room by making possible the early starting of presses which otherwise would stand idle awaiting their plates, and thus fewer presses need be used. Furthermore the Autoplate shortens the time between the receipt of news and its publication, and reduces the cost of stereotyping.

The following is a brief technical description of the machine itself. The core, about the lower half of which the plate is cast, is a cylinder having a journal at each end. These being supported by the housing of the machine hold the core in a horizontal position. The cylinder is fed with cooling water, which enters through one journal to spray the upper side of its inner surface, and is siphoned out through the other. The cylindrical core has an intermittently turning movement: for seven-eighths of a complete action of the machine it is stationary, and during the other eighth it is given a half turn and brought to rest. Thus each of its two semi-cylindrical surfaces or faces is alternately beneath and above. Beneath the cylinder is a co-operating concave part called the "back," which has a periodical up and down movement of about six inches. When in its uppermost position it embraces the lower half of the core with space enough between the two in which to cast a plate of the desired thickness. For three-fourths of the machine's cycle of operation the back is in engagement with the core, after which it drops away to permit the semi-rotation of the cylinder. The back, when casting is not being done, lies at rest in its lowermost position ready to receive a matrix. At each of the straight sides of the back is a sliding bar carrying a spring-seated matrix clamp. These bars are secured together and can be moved out or in after the fashion of a drawer. Extending from the back toward the operator is a concave continuation of the back, upon the straight edges of which these matrix bars run to their outermost position. This extension is called the loading tray. In it the matrix is laid to be put into the clamps. After the clamps have closed upon it, the clamps and the matrix together are slid into the space intervening between cylinder and back. Then the casting lever is thrown down, and the parts of the casting mechanism go into operation, when the back, carrying clamps and matrix, closes up beneath the under side of the cylinder, and the matrix is automatically positioned within the circle of the box. Thus there is provided between core and matrix a semi-circular space equal in length, breadth, and thickness to the size of the plate to be cast. At one of the straight ends of this space and completely closing it is the long straight mouth of a pump spout. Through this spout, rising from a pump which is immersed in a caldron which usually holds 12,000 pounds of molten stereotype metal, the charge of metal is sent immediately into the casting space described the instant the back has formed it. The opposite straight side of the casting chamber having already been closed by the matrix clamping bar carried at that side by the back, the space is sealed and the charge of metal injected (about 40 pounds) is securely held until it has been cooled by the water-chilled cylinder and back. As the pump plunger is operated by a cam-compressed spring which continues to apply pressure to the metal in the chamber during its solidification, the shrinkage of the cast is minimized. In the Autoplate machine metal is usually run at 575 deg. Fahrenheit, and a half-inch plate requires about ten seconds in which to solidify. Therefore after ten seconds of dwell the pump plunger is released, and draws down from the mouthpiece all the molten metal it contains, thus leaving nothing but the cast to be dealt with when the chamber is opened. So sharp is the line at which congelation ceases an inch above the head of the plate that after the remaining molten metal has run back into the pump cylinder, and the plate has been ejected, no metal either in molten or solid form is left in the mouthpiece to cause clogs or other difficulties. The cast being hard, the back descends and the matrix-retaining clamps, which are spring-controlled, gently strip the flexible matrix from the plate. This still adheres to the under side of the cylindrical core about which it has been cast. So soon as the stripping of the matrix is finished—a delicate operation performed with great dexterity and speed by the machine—the cylinder is caused to make its half revolution and the plate is brought thereby out of its position beneath the cylinder to that above it and comes to rest. Then the back, with its matrix, once more closes against the under side of the cylinder, the pump acts, and another plate is cast, this time upon the reverse side of the core. Meanwhile the first cast has been lifted from the top of the core and pushed along upon its straight edges between two horizontally rotating saws making 3500 R. P. M. These remove the narrow sprue cast upon one straight edge of the plate, and the narrower over-cast portion at its other straight edge, and trim the plate at both edges close up to its type surface. After passing the saws the plate goes beneath the dome of a shaving arch, where it comes to rest. Into the smooth inner curve of this it is then lifted and clamped, and a straight rotating knife promptly smooths out its inner surface ribs, bringing it thereby to proper thickness. As the process of shaving gives the plate not only its thickness but also the exact curvature of the press cylinder upon which it is to be clamped, it is most important that it be accurately performed. This is insured by having the parts of great strength and accuracy, and by passing water through the arch casting. The latter prevents the distortion of the arch, and consequently of the plates, which would occur if the shaving arch were permitted to accumulate heat and expand. At each end of the shaving knife is fixed a small hook-like chisel. This reaches over the beveled edge of the plate made roughly in casting it, and trims the edge close to the type. By this time a second cast has reached the "shaver," as that device is called, and the first plate, being finished, is drawn out by an arm and passed over a wetting apparatus. By means of the latter the plate is given a final cooling from its inner side only, which leaves the type side dry. The plate, now finished and cold, is ready for press.

The fundamental principles of the Autoplate machine may thus be set forth:

The cast being made upon the under semi-diameter of a cylindrical core may be quickly and easily ejected by a half turn of the core. This arrangement permits of a double speed in casting, as two core surfaces are alternately used, the one having opportunity to cool while the other is in use. It further provides two natural postures for the work of casting and delivering the plate. Thus the plate is cast with its printing surface beneath, which insures a good face, and upon its ejection from the casting chamber is left face up, resting upon its two straight edges in position to be most easily mechanipulated.[*] Moreover, as the operation of casting the plate occupies but the under part of the core, and that of delivering it from the core occupies only its upper part, both functions may simultaneously take place. This greatly increases the celerity with which the machine may be worked.

The matrix is mechanipulated, the mechanism used for the purpose acting with a gentle, uniform motion, to position the matrix with accuracy for each cast to be made, and to strip it from the resulting cast without injury of its delicate texture. Thus as many as one hundred casts have been made from one matrix.

Several safety appliances are embodied in the machine. One consists of a stud with a V-shaped nick which is cut to surround its middle portion. This stud, being inserted in a hole common to two adjacent elements of the driving mechanism, served to communicate from one to the other the power furnished to drive the machine. As the nicked portion of the stud lies at the point of juncture of those elements, and its nicked section is of sufficient strength to transmit the necessary power, it will serve under normal conditions to drive the machine. But as the nicked section of the safety pin, as this is called, is weaker than the weakest part of the machine, it will instantly give way if the machine be obstructed, and the machine will then come at once to rest. The obstruction havng been removed and another pin inserted, work may mmediately be resumed. As Autoplate machines were o be used by workmen unskilled in the care and use of automatic machinery such a safety device became necessary. Error-preventing appliances, also, are employed. By means of these it is not possible, for instance, to insert the matrix-clamping mechanism in he casting chamber unless, the matrix being inserted, all its parts are in proper position; nor is it possible o start the casting mechanism to work until the matrix-clamping device is safely and properly positioned n the casting chamber. During operation the matrix device cannot be withdrawn from the chamber, for in order that it may be withdrawn casting must first cease. While the casting chamber is open, and the matrix parts are out of position, the pumping system is under restraint, so molten metal cannot, by any carelessness of a workman, be ejected. The Autoplate machine has so successfully been made "foolproof" hat a mishap is an extremely rare occurrence

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[*] Read before the Franklin Institute.

[*] In my experience I have frequently felt the need of a word which should express the "handling" of its work by a machine, as the word *manipulate* expresses the handling of the work of a man by his hands. To fill the gap I have made bold to coin and use the word mechanipulate, which is here employed.

Autoplate machines cost $25,000 each The New York Herald has three, the New York World four, the New York Times two, the Chicago Daily News four, and the Tribune of Chicago three Other large newspapers throughout America, Great Britain, and Europe also, have them in use Many instances of pay roll savings, ranging from $30,000 to $40 000 a year, may be set to the credit of this machine; while in the saving of time, a still more valuable consideration, some surprising results have been achieved. One of the largest New York daily newspapers, for instance, is now closing its type-pages twenty minutes later than it formerly could, and whereas its whole battery of presses used to require an hour in which to be set to printing, it is now got to work in less than fifteen minutes The gain of this particular newspaper may be summarized as a yearly saving of over $40,000 in wages; twenty minutes of added time in which to gather news and advertisements, and the ability to get all of its presses running some forty minutes earlier than formerly, which enables it to catch earlier and more trains and thus vastly to extend the area over which it circulates In addition to these advantages this newspaper has been able to increase its selling time on the street, and greatly to improve its typographic appearance

Coincident with the adoption of the Autoplate machine by the dailies of the larger cities there arose a demand, from newspapers of lesser magnitude, for a similar machine suitable to their needs This was supplied in the Junior Autoplate, a very much less expensive apparatus, but one built upon Autoplate principles Several functions, in the parent machine automatically performed, in the Junior Autoplate were assigned to attending workmen The cylindrical core was stood on end and, with the back, which was similarly positioned, was given additional length to provide a sprue of sufficient height to insure the pressure necessary for perfect casting In this machine the casting space was left open at its upper—its curved—end and was filled from an over-hanging spout by means of a hand worked pump, immersed in a 10,000-pound pot of molten metal The back was moved to and from the core by a hand worked lever, and after the cast had cooled and the back had been drawn away, the operation of a hand worked clutch-lever set the cylinder to making a half turn, by power As in this case the plate was "poured" at one of its curved ends, its straight sides required no subsequent sawing; nor did they require hand-dressing, because of the fact that the matrix-edges and the clamps were made of such shape that all protrusions at the straight-edges, save only the type itself, were cast below printing height But the riser, which constituted the upper curved portion of the cast, as in the case of a hand-made plate, had to be removed This was done during the half-turn of the cylindrical core which turned the cast out of the casting chamber. Two saws were then thrown into position ahead of the plate, one at the height of the upper edge of the printing plate itself, and the other opposite its lower beveled edge As the cast passed these saws one severed the sprue from the plate while the other trimmed its lower edge Small pockets in the cylinder surface, into which the metal of the cast had run, acted during the sawing operation to hold the sprue and the plate securely to the cylinder, where these continued to cling after they had been sawn apart The cylinder having come to a stop, the back, with the matrix, was again closed upon its rearmost side, and another charge of metal thrown into the casting chamber. While this was being cooled by the water-circulation of cylinder and the back, the workman removed the first sprue and, after tossing it into the pot, removed the first cast This he dropped into the old, conventional shaving device, and planed it out in the usual way After having been shaved, dipped, and dried by hand the plate was then ready for use The freeing of the sprue and cast from the cylindrical core, it should be remarked, was accomplished by means of a slight blow delivered by the straight edges of the back when closed for a succeeding cast Thus freed from the core the plate was left standing upon a shelf, upon its lowermost curved edge, whence it was removed by hand The sprue, still held to the cylinder by a couple of pins, from which it hung, was easily removable by hand Two unusual engineering practices were necessary in this machine The saws, making 4 000 R P M, had to be driven to cut in the same direction as the cast moved. This was done so that their dust should not be thrown into the casting chamber to prevent its making a tight joint at closing The upper saw had to be set to cut directly against the iron of the cylinder Both were successfully accomplished, and have since worked without trouble But one further feature of the Junior Autoplate machine need be mentioned— the device employed to inform the workman when to open the casting chamber In hand casting it is left to the operator to determine just when the cast is sufficiently hard to be removed Thus, much time is unnecessarily lost It was to save this waste of time that an announcing mechanism was applied to the Junior. It consisted of a gong and a slowly driven toothed wheel, by a notch of which a spring pressed clapper could be engaged and cocked A cam-like piece secured to the framing, but adjustable about the center of the wheel was provided to trip the spring pressed clapper at any given point which might be chosen, and permit it to fly back and strike the gong Thus, if the tripping cam were set at a point to reach which it required the notch of the wheel that held the clapper level ten seconds of time, the gong would be sounded ten seconds after the clapper had been thrown into engagement with that notch From the handle of the pumping mechanism used to fill the casting chamber depended a finger, which acted to cock the clapper at the moment the pouring stroke of the pump lever occurred By this arrangement the gong, if its cam were adjusted to allow the normal time required to cool a cast, made from metal at a given temperature could be depended upon accurately to announce the arrival of the moment at which the cast should be removed To set this device it required merely a knowledge of the speed with which the particular metal used solidified

In the Junior Autoplate, it will be observed, the fundamental principles of the Autoplate machine recur: the matrix is stripped and repositioned without the intervention of the eyes or hands of the workman, casts are successively made upon alternate sides of a cylindrical core, a half turn of the core simultaneously ejects a cast and presents a fresh casting-surface; and the closing of the chamber frees the preceding cast from the core so that it may thereafter be removed during the succeeding casting operation. In the Junior Autoplate, however, a new principle, among other, minor ones, is to be found the cast is cut from its sprue while both are attached to the core, by means of a saw working in conjunction with the latter The rate of production of the Junior Autoplate machine is three plates a minute Its plates, however, as delivered by the machine, are not wholly finished, but require thereafter to be shaved, dipped, and dried

In many instances newspapers have purchased not one but several Junior Autoplate machines This has led to the construction of the double Junior, which consists of two Junior Autoplate attached to an elliptical pot one at each of its ends The pot employed is usually of 16,000 pounds capacity The machines are made right and left and are independent of one another Such an equipment requires the use of two matrices, one for each machine and its rate of production is six plates a minute

Having finished the construction of the double Junior Autoplate, a new apparatus called the Autoshaver was next provided, to shave cool and deliver, dry, the plates made by Junior machines This consisted of an inclined run way of stud supported, flanged wheels along which the plate might run by gravity, upon its straight edges At the upper end of this run way was a receiving station, its exit barred by a cam worked gate Next along the route of the plate came a shaving arch it also having at its lower end a cam worked gate, then below the shaving arch a water-saddle, the exit of which was likewise barred and, finally, beyond this a receiving station beneath which rotated a brush to clear the plate of such water as might adhere to its under side Driven by the operating mechanism of the machine were cams, which worked the gates a constantly rotating shaving knife within the arch clamps for therein securing the plate and the brush The shaving arch was cooled as in the Autoplate by the circulation of water which went thence to the water saddle There, over a series of riffles, the water broke into a cascade so arranged as to compel it to contact with the inner side of the plate which it cooled The Autoshaver made six revolutions a minute and was capable of receiving a plate at each revolution To use it, it was only necessary that a plate from a Junior should be placed and left on the receiving stand with its straight edges on the wheels of the run way At the proper moment the first gate opened and let the plate run into the arch, where the second gate arrested it There it was clamped and shaved and at the proper moment released to run out and onto the water saddle After having been there held for an instant, and cooled, it was released by the last gate, and ran forward to the delivery stand where being brought to rest by a stationary stop, it was brushed out, and thereafter stood ready to be sent to press Having a capacity of six plates a minute the Autoshaver was capable of finishing the product of a double Junior Autoplate machine Thus, it has become the custom to install with every double machine an Autoshaver The New York American, for instance, uses three such equipments, having a combined capacity of eighteen finished plates a minute In this newspaper office its Autoshavers are so arranged that their finished plates are taken from them by automatic carriers to the various press rooms in which they are to be used Thus, a stereotyper touches a plate but once, in transporting it from Junior to Autoshaver

In concluding the subject of the evening, it may lend a touch of human interest to what has been of necessity but a dry relation of mechanical facts, if I state that nearly $2,000,000 worth of Autoplate machinery has been sold at home and abroad; and that it has been carefully computed that in the United States and Canada there is now being made by its use a yearly saving of over $350 000

THE EFFECT OF WATER UNDER PRESSURE ON TRANSPLANTED TREES

The growth of transplanted trees is often greatly retarded, if not entirely checked, by the desiccation which the trees have experienced in the course of their removal from the nursery to their final sites. For this reason the agricultural experiment station of Wisconsin has been trying the effect of restoring to the tree the water lost by evaporation, by applying water to the roots under slight pressure. In order to carry out this plan it is necessary to have a certain quantity of water supported at the level of the top of the tree and placed in communication with a root by means of a tube, so that the pressure exerted by the column of water can be transmitted to the sap vessels. The apparatus used is very simple, consisting of a small vessel attached to a piece of gas pipe, which is closed at the bottom. The root is connected with the gas pipe by means of a rubber tube and a lateral tubulure. At the moment of application one of the large roots is laid bare, and the apparatus is set up at such a distance that the rubber tube can be easily connected with the root, where it is made fast by tying. The vessel is then filled with water, which is absorbed more or less rapidly, according to the condition of the tree. The effect of the operation is often perceptible within forty-eight hours A beech trees transplanted in April was subjected to the treatment some time in May, when it had given no indication of life. Six days afterward the buds opened and the leaves appeared Similar results were obtained with plum trees, but the most striking result was obtained with seedling apple trees Twenty of these trees had been used during the winter by the students in practice in transplantation, and had consequently been exposed to many variations of temperature and moisture. In the spring all of these trees were planted in the same manner, and in the same soil, and half of them received the hydraulic treatment. A week after the treatment, the trees which had received it began to open their buds, and two weeks later they were in full leaf. During this time only one of the untreated trees had shown any indication of growth It should be observed, however, that in autumn all of the trees, with the exception of two of the untreated trees which had died, had made substantially equal growth Hence the benefit produced by the water treatment appears to be confined to rousing dormant life and accelerating initial growth.

This treatment, which has been known since 1897, is indicated whenever young trees have been made unusually torpid by freezing or drying, and when it is desired to transplant trees without cutting them back —La Nature

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The Electrical Engineer gives the following particulars relating to some of the latest improvements in the Berlin electric railways. The driver's cab now forms part of the guard's van, and the guard's seat is opposite a window looking into the cab, so that each can co-operate fully with the other If by any chance a train passes a danger signal, its brakes are automatically applied by means of contacts in the permanent way, which actuate the brakes by means of an apparatus on the roofs of the coaches, while at the same time a signal appears in the van showing what has taken place If signals are overrun at the junction, danger signals--stopping any train which might collide with the first—are automatically exhibited.

HALLEY'S COMET AND THE TALMUD

It can hardly be disputed that the honor of having been the first to place cometary theories upon a scientific and mathematical basis belongs to Halley who inspired by the labors of his friend Newton subjected comets to the law of universal gravitation and thus forever dispelled the mystery with which comets had been hedged before his time A writer in Revue Générale des Sciences Pures et Appliquées wonders whether it would not be of interest to ascertain if before him any scientist had thought of the periodicity of comets In studying certain passages of the Talmud he believes to have discovered evidence that the ancient [illegible] of Palestine suspected the periodicity of some comets at least Here for example is the textual translation of a fragment which seems to the author in question to apply to Halley's comet

Two wise men of Palestine Gambiel and Joshua together made a voyage on the sea The first had brought with him bread to eat The second one in addition had brought flour When Gambiel had eaten all his bread he asked his companion for flour and said to him How didst thou know that we should be so long time on our journey that thou didst provide thyself with flour? To which Joshua did answer There is a very bright star which appeareth every seventy years and which deceiveth mariners I have thought that perchance it might surprise us during our voyage lead us astray and thus prolong our voyage on the sea Hence it is that I have provided myself with flour

The difference in the period indicated (70 years) and the actual period of Halley's comet (7[illegible] to [illegible] years) is easily explained by the fact that in ancient Hebrew texts figures are usually given in round numbers It is not at all surprising therefore that Asiatic astronomers should have placed the period of cometary revolution at 70 a number sacred among the Hebrews

The star referred to may have been the apparition of the year 66 Indeed Gambiel II one of those who figure in the narrative was born in the first half of the first century of our era and was Nassi or supreme head of the Jews from the year 90 to the year 110 in the school of Jabneh a town of Palestine situated on the shores of the Mediterranean between Jaffa and Asdod This school in which religious problems were studied and commentaries evolved which later were joined to form the Talmud was founded by Jochanan ben Sakkai after the destruction of the temple of Jerusalem in 70 A D Gambiel was a learned man Besides his mother tongue he spoke Greek and Latin and was well versed in astronomy as well as his friend Joshua less known than he The nearness of the sea facilitated numerous voyages which they often took together either for commercial or other purposes

In the year 9[illegible] Gambiel went to Rome to intercede with the Emperor Flavius Clemens in favor of certain coreligionists These details would seem to show that the legend is based upon historical fact

The question now arises as to whether this star which appeared every 70 years really was a comet There can hardly be any doubt of that for there is no variable star of so long a period We should be compelled to assume that a variable star had arrived at its last stage of stellar life after slowly fluctuating in brightness through vast spaces of time and was eventually extinguished or at least so diminished in brightness in the interval of eighteen centuries, that no appreciable change could be detected by a modern observer This is hardly likely The hypothesis of a periodic comet seems most logical and receives support from the greatest of the old Talmud commentators the celebrated Raschi who lived in France from 1040 to 11[illegible] The ancient navigators said he were guided by the stars only They knew the certain positions for certain constellations in the heavens at different times of the year They knew which group should lie to their left and which should lie to their right in voyaging from port to port It is conceivable that the appearance of a bright star moving rapidly among the stars and visible sometimes in the north and sometimes in the south would in their minds disturb the harmony of the constellations and possibly lead them in error

If one seeks to identify the apparition about which Joshua and Gambiel conversed with one of the comets mentioned in historical and astronomical annals Halley's comet alone would seem to fit the necessary conditions particularly in the light of the foregoing explanation of Hebraic periods Assuming that Asiatic astronomers of the first century of the Christian era suspected the periodicity of this famous celestial wanderer it must be admitted that some of its previous apparitions were carefully observed The apparition immediately preceding that referred to occurred in the year 12 before our era (perihelion passage October 8th) On the other hand Crommelin has identified Halley's comet with apparitions of the years 87 163 240 and 467 B C

TRADE NOTES AND FORMULÆ.

Process of Producing Silver Tincture from Fish Scales (according to a new method recently patented in Germany) – Hitherto the so-called silver tincture has been made by dissolving the glittering substance from fish scales in water This so-called pearl essence was mixed with gelatine and applied in a warm condition Such a tincture is not adaptable for flexible objects because the coating on account of the gelatine it contains cracks off on bending Moreover it cannot be applied at all by spraying and only with considerable difficulty by means of a brush All these objections are supposed to disappear in the product made according to the invention in question The claims of the patentee are as follows Process of making silver tincture from fish scales consisting in that the shining substance of the fish scales dissolved off in water freed from water by water expelling fluids miscible with varnishes and without previous drying is mixed with an elastic varnish for instance celluloid varnish

The Manufacture of Patent Leather—Of a good leather varnish it is required that it will intimately adhere to the fibers of the leather that it will dry well be flexible when cold and in addition to this waterproof To impart these properties to the varnish perfectly purified linseed oil known as varnish linseed oil must be used which has been freed from palmitin by treatment with fuming nitric acid The linseed oil used for the preparation of the varnish must have been long in storage which is recognizable in its perfect yellow color and transparency whereas new oil has a greenish and turbid appearance and contains more water than old oil The oil is first heated in an iron kettle at 1[illegible]0 deg C until the formation of foam ceases then heated to 2[illegible]0 deg C when it will assume a bluish green color any fibrous tough particles separated should be carefully skimmed off Next day the oil is quickly heated to 3[illegible]0 deg C and kept at this temperature for six hours which usually results in a sufficient concentration which may be recognized by the rapid drying of a sample on a glass plate and in its hard and glossy character When besides a sample applied to paper produces no grease spot, the oil is quickly cooled to 1[illegible]0 deg C and then 3 per cent of litharge or 1[illegible] per cent of borate of manganese added To obtain brilliancy and hardness at a temperature of 2[illegible]0 deg C [illegible] per cent of brown umber or 10 per cent of Angola or Kauri copal is added After the addition of lamp black or diamond black the foundation color is applied to the grained side and the dried surface polished smooth with pumice stone then the black coat is applied and after this has been dried in an oven at 40 deg to [illegible]0 deg C in some dust free place the last varnish coat is applied by means of a horse hair brush or the varnish spray

Porcelain Cameos First a frit is prepared 25 parts white quartz sand 16 parts white potash and 8 parts soda crushed sifted and well mixed in a bowl well lined with thoroughly beaten sand and placed on the hearth of a faience kiln Take the frit from the kiln clean it crush it and grind it in a faience mill with stones of sandstone To 2 parts of ground frit take 1 part of porcelain mass (previously washed in the usual manner) Blue color for cameos [illegible]0 parts of cameo mass, 2½ parts washed porcelain clay and 5½ parts of cobalt blue (The latter prepared from half a part of cobalt previously crushed and sifted exposed in a crucible half buried in sand to the heat of a hot faience kiln fire crushed, sifted and to 2 parts 1 part of frit added and returned to the kiln) Preparing the cameos An annular copper mold is evenly filled with white cameo mass white paper and felt disks placed above and below, and the whole put in a press Take it out, remove the felt disks, apply the cobalt blue, replace the disks, and return to the press Take it out, place between wet cloths and keep it in a damp place To produce the cameo A copper plate, on which the desired design is engraved in the form of a seal, is rubbed with oil or spirits of turpentine the engraved places filled with white cameo mass and placed over the above described form filled with blue covered mass The whole placed in the press After pressing and removal of the copper plate it is fired in a faience kiln

Asphalt Cable Mass.—This substance is employed for filling out cable sockets and pipes for which purpose refined bitumen is used or, owing to their smaller cost commoner substances such as plaster, clay etc., mixed with it Ozokerite and Chatterton compound are also employed for this purpose, the latter a mixture of 65 parts gutta percha 18 parts of wood tar and 25 parts of rosin As a suitable cable mass, that is for the insulating or non-conducting impregnation of cables black cable mass is employed with tar and asphalt as constituents Also purified bitumen after it has been vulcanized by the admixture of 5 to 20 per cent of sulphur generally carefully prepared and made elastic so that when the cable bends it will not break Heated Chatterton compound is also extensively employed in order that in cable making a close contact of the gutta percha will be obtained

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SCIENCE NOTES.

The radio-activity of potassium salts has been investigated by J C McLennan The method adopted is the following One vessel is placed within and insulated from a second and the electrical charge which the insulated vessel more or less rapidly acquires is then observed Preliminary experiments were made on the charging action of the radiation from polonium and that of the secondary rays excited in Al by the γ rays from Ra the charges acquired by Ur salts at low pressures were also observed In the case of potassium salts the results show that in high vacua both potassium nitrate and potassium sulphate emit an excess of charged particles of the β-type The effect observed in all cases was small and it required exceptional conditions to bring it into evidence It was not found possible to decide whether any radiation of the α type is emitted by the potassium salts or not

H. Siedentopf calls attention to a new step in ultramicroscopy in the proceedings of the Deutsch Phys Gesell After recounting the optional conditions necessary to make ultramicroscopical particles visible he describes a new luminous ultramicroscope and its manipulation Complete 'dark field illumination' i e illumination round the edge of a central screen or stop is attained by means of two dark field condensers the paraboloid or the cardioid condenser The aplanatism of the latter depends on a remarkable hitherto unknown property of the cardioid The efficiency of the new appartus is due in addition to special quartz chambers and new objectives Work with the instrument is described including new observations on the Brownian movement on the shape of ultramicroscopic metal particles on microchemical reactions and light reactions The reduction of white silver bromide in water to polychrome silver particles resembling a Lumière autochrome plate is also described with the aid of colored drawings

The invention of spectacles is usually assigned to the end of the thirteenth century but Gaudin and Regnault have recently made a communication to the French Society of Anthropology which, if it is confirmed will carry back the invention to a much earlier date These scientists in fact have presented to the society a pair of spectacles which they claim to have found in the excavations at Smyrna. According to the description of the drawing submitted these spectacles are of peculiar form, each glass is mounted separately and the two mountings are connected by a movable joint so that one can be folded upon the other Each mounting is circular and is provided with a groove for the reception of the edge of the circular lens One of the lenses, greatly corroded, is still in place It is a double convex about 1 4 inch in diameter The ring of metal which forms the mounting is not complete; but leaves about ¾ inch of the glass exposed and acts like a spring It can be opened for the insertion of the lens, and its elasticity then holds the lens in place It should be added that these spectacles were not found *in situ* and consequently it is uncertain whether they belong to the Greek or the Byzantine period. There can be no question that they are very ancient, but it is evident that the value of this discovery is at present only provisional.

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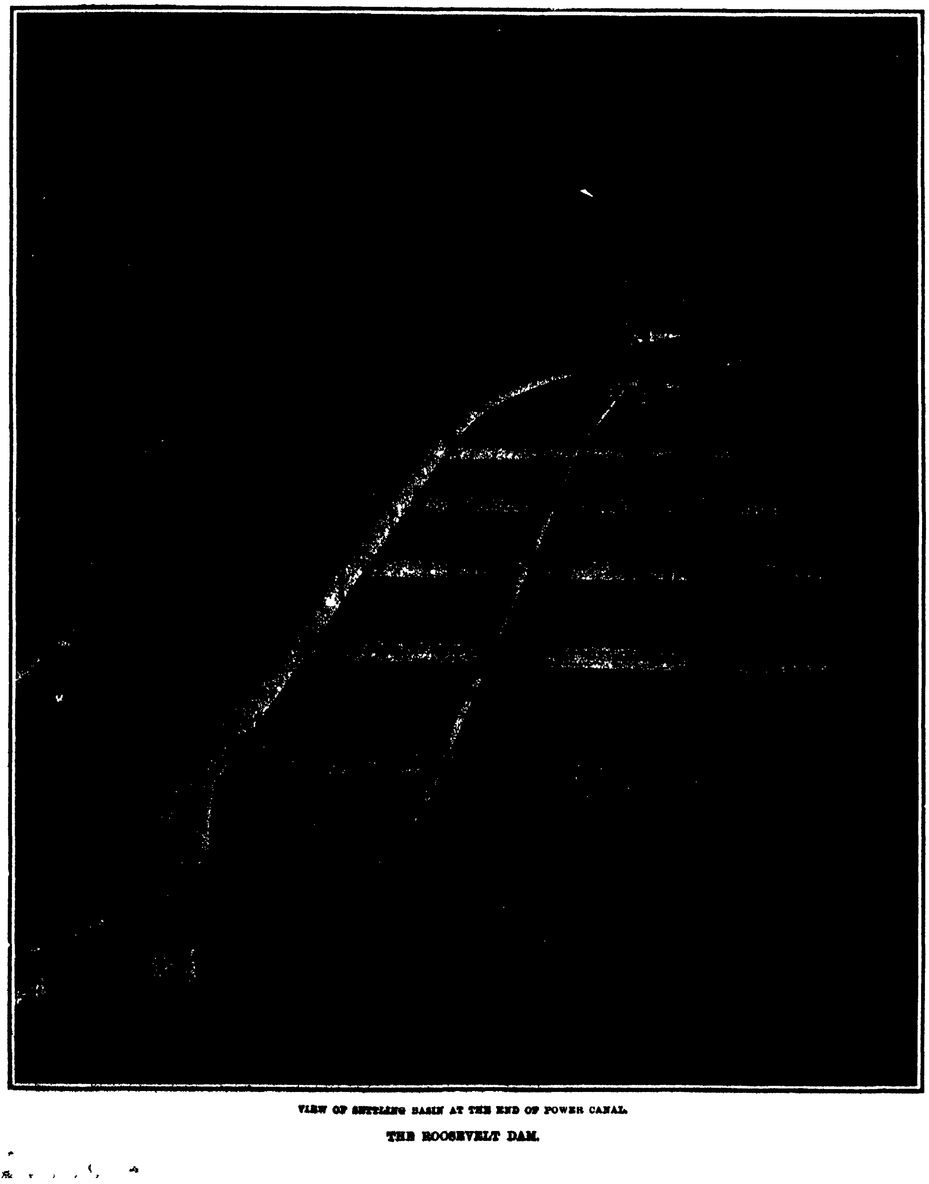


VIEW OF SETTLING BASIN AT THE END OF POWER CANAL.

THE ROOSEVELT DAM.

THE ROOSEVELT DAM.

WATER AND POWER DEVELOPMENT AT SALT RIVER, ARIZONA.

BY EDMUND G. KINYON.

The government dam across the Salt River at Roosevelt Arizona is nearing completion after about six years of active building. The cap stones have been placed in position on the first [illegible]-foot section of the structure and it is expected that the entire masonry work will be finished during the present year.

Taking the south end of the dam as the initial point the following heights have been attained.

The first [illegible] feet is [illegible] feet in height, the next 30 feet 238½ feet, the next 100 feet [illegible]8 feet, the next 60 feet [illegible] feet, the next 100 feet [illegible]00 feet, the next [illegible] feet [illegible] feet, the next [illegible] feet 180 feet, the next [illegible] feet 190 feet.

The total length thus aggregates [illegible] feet but these figures will be increased somewhat when the entire length of masonry is brought up to a level.

The dam is already in practical use and nearly [illegible]00 000 acre feet of water is stored behind the massive base awaiting its mission in the fields far below. Measured at the dam the depth of water is about [illegible] feet. As the lowest unfinished section is 180 feet in height there still remains [illegible] feet of resisting dam available. At the 180-foot level the amount of water stored would be [illegible] acre feet. The completed reservoir will be [illegible] miles wide by [illegible] miles in length.

Three methods are provided for drawing the water off as it is needed.

Through a power canal 18 miles in length having an elevation of 210 feet above the level of the river at the crest of the dam where it enters a penstock that runs to the power house below the dam and about [illegible] feet above the level of the river.

Through a 10-foot diameter pipe penetrating the dam starting at its upstream face about [illegible] feet above river level and terminating at the power house.

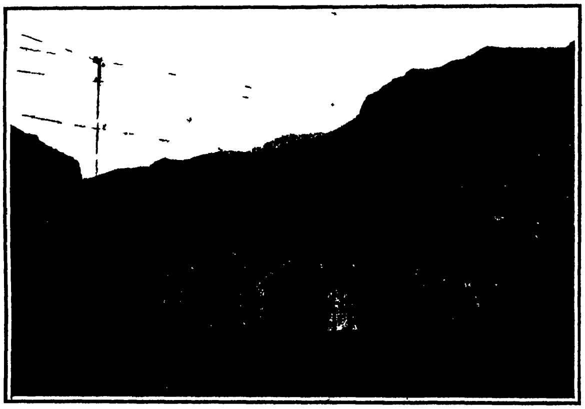
Through the sluicing tunnel 12 by [illegible] feet that leads at the level of the river through the mountain side to the river below the dam.

Any or all of these methods may be employed as the height of the stored water and other conditions require.

The area of land to be irrigated by means of the reservoir is about [illegible]10 000 acres lying in the valleys of the Salt and Gila Rivers from 60 to 200 miles below. Of this about 190 000 acres may be reached by gravity leaving [illegible]0 000 acres to be served by pumps driven by electric power generated by means of the flowing water.

The plan to secure a supplementary power service from the dam is now being put into practice. In all it is calculated that [illegible] 000 horse power can be developed. Starting at the dam for a distance of 60 miles the water is being harnessed no less than eight times wholly or in part each time developing energy ranging from [illegible] to [illegible] horse power. All of the power developed at the various stations is brought together by cables and carried through the mountains and valleys by a system of transmission cables. The city of Phoenix is already using 2 000 horse power and power is for sale to all who desire to purchase.

As far as possible however the government will use the power to expand its irrigation plans. By means of a transmission line power will be carried a distance of 100 miles to the Sacaton Indian Agency there to pump water for the irrigation of 10 000 acres of land to be cultivated by the Indians. Wherever within a radius of [illegible]00 miles bodies of underground water can be found adjacent to suitable land the power will be conveyed and harnessed to pumps. In this way the benefits of the great engineering undertaking will be extended from one-third to one-fourth over the original expectations.



VIEW OF THE DAM AS IT EXISTS TO DAY

VIEW OF POWER CANAL AND GOVERNMENT CEMENT MILL.

THE ROOSEVELT DAM.

ENGINE ROOMS ANCIENT AND MODERN

The men of the present generation who go down to the sea in ships cannot possibly realize says the Engineer the magnitude of the difference between a modern and an ancient engine room. The word ancient expresses a relative idea. Steam engines are all modern as compared with the potter's wheel or the water mill or the loom. But compared with each other they are ancient and modern. Anyone in doubt can settle the point by a visit to the South Kensington Museum. The distinguishing feature of the old-time engine room was extreme simplicity, fewness of parts. There was a cylinder and a piston, a crosshead, two side levers, a connecting rod, a crank shaft, a long D slide valve worked by a single eccentric with a gab and a pin. Then there was a jet condenser, an air pump and a feed pump and that was about all. An ordinary copper kettle containing tallow stood on the cylinder cover that it might be kept hot. A little was administered now and then on the up stroke through a cock when the vacuum sucked it in and so stopped the groans of the piston. That was the equivalent of up-to-date *forced lubrication*. The boiler pressure was 10 pounds to 15 pounds and the consumption of fuel was at the rate of about 6 pounds per indicated horse power per hour. To make a complete drawing of such a marine engine was a very simple affair. Some excellent examples are to be found in 'Bourne on the Steam Engine.' There is still in existence a very scarce manual of the marine engine written by Maine and Browne and published under the auspices of the Admiralty for the use of naval engineers. Among the instructions given are those relating to the precautions to be taken when a ship was going into action. It will be remembered that the boilers were rectangular—much the shape of a biscuit tin with the corners rounded off. The engineer was instructed to have ready numerous pieces of boiler plate and short lengths of timber. If a round shot came through the side of the boiler the hole was to be stopped by a piece of plate bedded on canvas coated with red lead putty, and secured in place by wedging a timber strut between it and the ship's side. Before going into action the pressure was always to be let down below that of the atmosphere, so that when the hole was made air might rush in instead of steam coming out. In this way the danger of a damaged steam pipe was minimized. This reads like a jest now, but it was not a jest. It was a serious Admiralty instruction. We have not heard of any instance in which repairs were effected in this way; nor, indeed, of much mischief ever having been wrought by round shot in engine or boiler rooms. It was a curious fact that during the

Crimean war a paddle wheel was never disabled although the paddle boxes and paddle box boats of steam frigates like the old "Terrible were knocked to pieces

Of the modern marine engine room most of our readers have no doubt an idea To many of them it is familiar Its contents constitute a mass of mechanism There are miles of piping hundreds of valves of the most varied kinds There are two sets of engines instead of one there are at least six cylinders instead of two and the piston valves are so large that it is easy to mistake the valves for the cylinders from the upper platform And then the auxiliaries the forest of pumps the feed heaters the distillers the filters the lubricators the expansion gear the reversing engines to say nothing of dynamos and refrigerators and hydraulic machinery and a multitude of small things each and every one demanding attention Then the pressure 180 pounds to 220 pounds which tries every joint The old fashioned shovel had a very easy and irresponsible life compared with that of the marine engineer of the present day

Let us ask ourselves the cause of the change Why has complication taken the place of simplicity? Why are there so many things in an engine room that our fathers or grandfathers did without? And did without while opening up the commerce of this country with the world and entering on voyages and undertaking risks of very great magnitude The answer is quite easily given They are one and all the result of a desire to save fuel There was only one effectual method of doing this Pressures must be raised and steam expanded Formerly the jet condenser was used It was simple cheap demanding little or no attention giving an excellent vacuum at a very moderate cost The boiler was fed with sea water and about one-fifth of the feed had to be blown hot over board This represented a loss but not a great one Attempts were made to raise pressure but about 30 pounds was the limit At the higher temperatures salt was just as soluble as at low but sulphates of lime and magnesia become insoluble and being thrown down on the heating surface formed a hard scale It became clear that if pressures were raised the boilers must be fed with water free from scale making impurities Enter the surface condenser upon the scene Great difficulties were encountered and dozens of patents taken out for getting over them It was all experiment and as usual the solutions of the problem were supplied by practical men • Like most other things in a ship the surface condenser as we have it is a survival of the fittest With it came centrifugal circulating pumps and other delights for the marine engineer The coal consumption fell A horse-power could be had for 5 pounds per hour There was no longer a limit to boiler pressure and 60 pounds came in and with it various forms of the compound engine Need it be said that the result was more complication? But consumption fell A compound engine with 70 pounds pressure got on with as little as 3 pounds or 3½ pounds of coal per indicated horse power The cylindrical or Scotch boiler took the place of the box boiler and pressure rose to 80 pounds There it remained for some time The introduction of steel bigger plates and better machine tools was followed by gradual rises A third cylinder was added and pressure rose to 160 pounds Finally came the quadruple-expansion engine with four cylinders and four cranks and 220 pounds pressure and a horse power for about 1 pound of coal

All the changes which have taken place during the last half century have resulted from the search for economy of fuel and the discovery that it could only be secured by raising pressure All that is said and argued on theoretical grounds about the multiple-cylinder and the heat trap has no practical significance The reason why the modern is so much more economical than the ancient marine engine is simply that it works between greater temperature ranges But for mechanical reasons high pressure steam cannot be worked in single cylinders hence compounding Much that is of interest will be found by the marine engineer of to day who will ask himself why things are as they are and not as they were Let us suppose for a moment that no possible advantage could be gained by carrying a higher pressure than 20 pounds If that were true then the modern engine room would differ very little indeed from the ancient engine room Rectangular boilers would still be used because they take up less space than Scotch boilers It is probable but far from certain that surface condensers would be used Improved devices for handling the engines would be adopted Various precautions would be taken to prevent waste of heat and leakages of air to spoil the vacuum But there would be no compounding and the auxiliaries would be few and far between, there would be less stress on everything and very much smaller powers. But all this only goes to substantiate the argument that the difference between the ancient and modern engine room is due almost altogether to the augmentation of pressure Complication has gone hand in hand with rise of pressure Each change has entailed another, and so would change have gone on to the end of all things Now we have the turbine It promised simplicity It remains to be seen if the promise can be kept The turbine engine room certainly calls up few memories of the past Its complexities and troubles are all its own They must be serious indeed if they exceed those dealt with by naval engineers in charge of the reciprocating engines of a modern warship

TIRE INFLATION AND ADJUSTMENT

The manufacturers are universally agreed after spending much time and money experimenting and testing that certain air pressures should be maintained in all tires according to the weight they are to carry The necessary minimum pressure is stated by manufacturers to be as follows

3½ inch tire	60 pounds pressure
4 inch tire	70 pounds pressure
4½ inch tire	80 pounds pressure
inch tire	90 pounds pressure
½ inch tire	90 pounds pressur

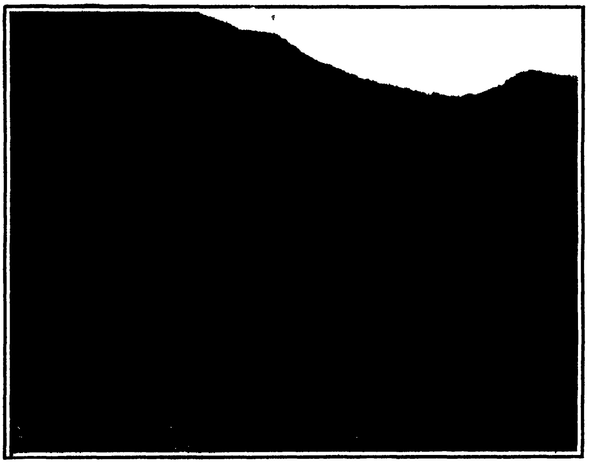
Inasmuch as tires are manufactured and sold under a guarantee for a certain mileage the guarantee is based on the understanding that they will be kept up to this pressure at all times and a number of makers attach a label or brand to the tire stating the required pressure for that particular size of tire If their force cars are run with tires inflated to a lower pressure, replacements cannot be justly expected from manufacturers When tires are returned for adjustment because of blow outs chauffeurs doubtless believe in the majority of instances that sufficient pressure has been maintained to justify the claim This of course is a matter of approximation or opinion unless a pressure gage is used

In the experience of supply departments claims are frequently made based on the statement that the right pressure was maintained being subjected only to a test of hand pressure and looks A test made by pressure gage indicates in nearly every case that the actual pressure is little more than 50 per cent of that required In one instance of a 935 by 135 tire on a limousine car weighing 5 000 pounds it was recognized and admitted by the owner and chauffeur that at least 90 pounds pressure was required and it was asserted that such was the pressure maintained as the chauffeur stated he had been inflating tires for more than ten years and believed his judgment could be relied on without the necessity for the use of a gage The tires were tested in his presence and 4 pounds and 40 pounds pressure respectively were indicated by the gage The necessity for gages to determine the proper inflation was immediately and frankly admitted

Tires are made of a number of layers of canvas over a spherical mold the layers bound together with an anti-friction compound Therefore if they are only partially inflated they are flattened out by the weight of the car When small stones are struck a brief and sharp depression is made in the tire which causes a break in the innermost layer of canvas which will soon chafe the adjoining layer and each layer will then go in turn until the tire finally blows out If the tire were well inflated the same stone could not make such a depression

A partially inflated tire is also damaged by over heating caused by internal friction of the layers which are forced out of their natural spherical construction on which they are intended to run causing the rubber tread to separate from the canvas allowing the water and dirt to get in between the layers of canvas when of course the whole tire is ruined

These are often the causes of what the owner or chauffeur calls a defective tire and are the occasion of just objection by manufacturers to a replacement All reputable manufacturers are ready and willing to replace defective tires and no trouble is found in the adherence to the mileage guarantee but proper inflation is justly and for the reasons stated desired and demanded



TRANSMISSION LINE THROUGH THE SALT RIVER CANYON AND OVER HIGH CLIFFS JUST BELOW THE ROOSEVELT DAM

THE ROOSEVELT DAM

THE PUREST WATER NOT ALWAYS THE BEST

A good drinking water possesses an agreeable flavor which it owes to the mineral substances which it holds in solution The most important of these salts is calcium bicarbonate the presence of which in small quantities should be considered as a hygienic requirement of drinking water Our organism needs lime salts for its development and even for its maintenance because it daily loses a considerable quantity of lime which must be replaced by lime contained in the food and drink Boussingault found that a young pig absorbed in three months about 1[illegible] ounces of calcium carbonate from water alone The proportion of calcium carbonate in drinking water however should not exceed one part in 2 000 If a larger quantity is present the water becomes heavy and indigestible Calcium phosphate also exists in water in small quantities held in solution by free carbonic acid This is a still more useful ingredient of drinking water because of the part which it plays in the development of the bony structure A full grown man loses daily about 2[illegible] grains of lime and [illegible]0 grains of phosphoric acid

The presence of calcium carbonate in water produces another useful result at least in connection with the water supply of cities Water which contains a smaller proportion of calcium carbonate than three parts in one million is incapable of covering the inner surface of lead pipes with the protective coating which prevents corrosion of the lead by the chlorides contained in all natural water and in resultant formation of small quantities of soluble and poisonous lead salts This consideration has led several cities including Sheffield England and Dessau Germany to add a certain quantity of lime to the water before it enters the pipes This process possesses the incidental advantages of sterilising the water to a certain extent and of adding a mineral ingredient which is required by the organism of the consumer —Cosmos

NEW METHODS OF POLAR EXPLORATION.

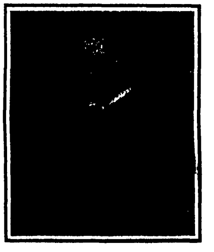
AN ACCOUNT OF THE COMING ARCTIC AND ANTARCTIC EXPEDITIONS.

BY F. MEWIUS.

The activity of recent explorers in both the Arctic and Antarctic regions has been crowned with so great success that the polar explorations of the last few years will occupy a prominent place in the history of geographical discovery Commander Peary who had already won celebrity through numerous polar expeditions as well as the now discredited Dr Cook claims to have reached the North Pole and Lieut Shackleton has penetrated the almost unexplored Antarctic continent to within 11[illegible] miles of the South Pole

These achievements show clearly the extent to which success in the attainment of high latitudes and the traversing of extensive and unknown polar regions is dependent upon the development of the technique of traveling by sledge although the ability of the commander of the expedition is of course a very important factor This development of the art of sledging is the result of the accumulated experience of many years After the endeavors to find a practicable ocean passage through the polar [illegible] to China and India had failed the North Pole itself became the principal object of Arctic exploration It soon became evident that little could be done with ships alone Wherever an attempt was made to proceed northward through Smith's Sound along the east coast of Greenland northward from Spitzbergen or Bering's Strait the ship's progress was arrested by impenetrable masses of ice At the beginning of the nineteenth century journeys by sledge were undertaken and since that time the sledge has been the most important auxiliary of the pole seekers and other Arctic explorers the ship serving only as a convenient point of departure for the sledge parties The difficulties which these parties had to contend with may be conceived when we remember that the polar ice is often accumulated by ocean currents and other agencies into masses of hills intersected by wide stretches of open water and that the entire mass of ice often drifts with the current Furthermore it is not possible to travel by sledge over the ice except during a short period in spring In order to use this period to the best advantage and to provide the expedition with good sledges and dogs and suitable equipment expert knowledge is required In this respect the greatest experience has been acquired by Peary who finally adopted the plan of employing Eskimos as his assistants

CAPT SCOTT (SEATED) AND HIS FIRST OFFICER LIEUT EVANS



LIEUT WILHELM FILCHNER

Meanwhile the dirigible airship is preparing to enter the field of Arctic exploration It is true that Wellman has not won his hoped for laurels but the reason of his failure may be found in the character of his preparations This fact increases the interest which attaches to the projected German Polar Expedition with Zeppelin airships the preparations for which are being carried out as the expedition itself will be conducted with characteristically German care and thoroughness The object of this expedition is not so much the attainment of the North Pole as the advancement of science In particular the meteorological conditions of the Arctic region will necessarily be very thoroughly studied According to the plan which has been decided upon a preliminary expedition will start during the coming summer when the German exploration steamer Poiseidon and the Norwegian Arctic ship Phoenix will proceed to Spitsbergen in order to seek and prepare a suitable place for an airship station It will also be necessary to make investigations concerning the polar ice the southern limit of which is usually found north of Spitzbergen at latitude 81 deg A still more important problem is the development of a suitable method of anchoring so that the airship can stop on its journey toward the pole for the purpose of taking soundings Two Zeppelin airships will be specially constructed for the expedition One of these vessels will perform the voyage of exploration while the other will remain at the station in Spitzbergen as a reserve in case of need The exploring vessel will keep in touch with the station by means of wireless telegraphy In order to prove the capability of the new airships to perform their allotted tasks they will be dispatched on journeys over sea from Hamburg during the summer of 1911 and will not be taken to Spitzbergen until the following year when the voyage of polar exploration will begin With this method of preparation it is reasonable to expect a successful accomplishment of the main expedition especially as an airship has a freedom of movement which is not possessed by any other vessel or expedition in the ice covered Polar Sea

This sea is however one of the most important fields of exploration in the Arctic region consequently much interest attaches to Capt Amundsen's projected expedition with the Fram Amundsen's journey like that performed by Nansen with the Fram will be accomplished by drifting The vessel will proceed through Bering's Strait allow itself to become frozen in the ice pack and then drift onward with the current This journey is likely to occupy three or four years during which the members of the expedition will be exposed to dreadful loneliness and monotony of life in the Arctic but it offers a prospect of traversing the immense and hitherto unexplored region which lies between Alaska and the North Pole In connection with Amundsen's expedition explorations in the Atlantic Ocean will be undertaken this summer after which the ship will start on its long journey to Bering's Strait *via* Cape Horn

It is probable that the Russian government will also send an expedition to the Arctic this summer in order to make explorations along the coast of Siberia in the interest of a possible future navigation of the Northeast Passage Two vessels have been constructed for this purpose with especial attention to their capability as ice breakers The doubtful point appears to be the appropriation of the large sum of money which will be required for the expedition itself and the auxiliary land expedition along the coast of the Taimyr peninsula

The well known Norwegian Arctic explorer Isachsen expects to complete during the coming summer the explorations begun last year for the purpose of making a scientific study of the coast and interior of the northwestern part of Spitsbergen Of especial practical value are Isachsen's cartographic photographs and drawings of the indentations of the coast and his soundings which make it possible for even large tourist steamers to visit these fjords with perfect safety On the east coast of Greenland a Danish expedition commanded by Capt Mickelsen has been waiting since last autumn with the object of seeking during the summer for the lost records of Mylius Erichsen who perished in 1907 in an attempt to cross the ice covered interior of Greenland In connection with this expedition the Danish explorer Knud Rasmussen will make studies of all the Eskimo tribes He will start from Cape York, north of Melville Bay and proceed to Hudson Bay and through the Eskimo territory extending along the north coast of America to the Aleutian islands Three years are allowed for the accomplishment of the work

Antarctic exploration will this year take the unusual form of a race for the Pole between Englishmen and Americans Encouraged by Peary's success in the Arctic the Geographic Society of Washington and the Peary Arctic Club of New York quickly decided at Peary's suggestion to fit out an expedition to compete with the British Antarctic Expedition in command of Scott Both expeditions will start this year and both have the same main object the attainment of the South Pole but they will seek this goal from opposite points, the English expedition starting from Victoria Land the American from Coat's Land in Weddell Sea discovered in 1904 by Bruce Both expeditions will be equipped in the best possible manner In the Terra Nova Capt Scott possesses an excellent vessel and he will carry sixty sledges and one motor sledge for the use of his various sledge parties Ponies and dogs are now being procured in eastern Siberia for the use of the expedition Dr Wilson a member of the Discovery expedition is the chief of the scientific staff The Terra Nova will leave England in July and in December will reach New Zealand whence the journey will be pursued to Victoria Land The winter station will be established probably in McMurdoch Bay in the vicinity of the volcanoes Erebus and Terror

The American expedition will make use of Peary's vessel the Roosevelt and will be commanded by Capt Bartlett On Peary's advice only dogs will be used for drawing the sledges In September the expedition will leave Punta Arenas in Tierra del Fuego, the most southerly settlement in the world and will proceed to Weddell Sea where its first task will be the rediscovery of Coat's Land

It is not easy to decide which of these expeditions the English or the American is most likely to reach the goal Scott's point of departure is the nearer to the South Pole and from it set forth the successful sledge parties of Scott in 1902 and Shackleton in 1909 For the purpose of geographical exploration however it is very advantageous that a second attempt to reach the Pole by a totally different route will be made In this way it is probable that our knowledge of the extent of the Antarctic continent will be greatly increased For though we know little of the Antarctic continent its existence can scarcely be doubted With the exceptions of Victoria Land and King Edward VII. Land all land masses which have been reached or seen by former expeditions lie at very great distances from the pole and about in latitude 66 deg These regions include Wilkes Land Kaiser Wilhelm Land Kemp Land and Enderby Land on the one side and on the other Graham Land Alexander I Land and Peter I Land contiguous to which is the region discovered by the Charcot expedition extending along the 70th parallel to about 125 deg of west longitude

By a remarkable coincidence a great German South Polar expedition which possibly will begin operations during this year has suddenly been projected Lieut Filchner celebrated through his extensive travels in Tibet is the originator and will be the commander of the expedition Combining scientific zeal with great energy and indomitable courage Filchner is the very man for this undertaking While the attainment of the South Pole is the main object of the American and English expeditions the objects of the German expedition are exclusively scientific, and consequently appeal to the interest of the entire scientific world Filchner purposes to traverse the Antarctic continent and to investigate the relations between its eastern and western parts for the purpose of deciding whether these really form a single continent or whether the western portion is merely a peninsula on the coast of the larger western land, connected with it only by a low lying ice-covered neck of land separating Ross Sea, adjacent to Victoria Land from Weddell Sea, in the South Atlantic The expedition will start from Weddell Sea but an auxiliary vessel will proceed to Ross Sea and will establish a depot of provisions as far south as possible at the foot of the lofty cliff, for the purpose of supporting the sledge parties sent out from the principal ship In this manner it appears possible to traverse the intervening land and solve the important question of food The plan is for the sledge parties to return to Europe by means of the auxiliary ship from Ross Sea. The celebrated Norwegian explorer Nordenskiold says that this plan is by far the most important and most valuable of all projects of

Antarctic exploration Apart from the great problems concerning the interior of the Antarctic continent which will be solved by it, the expedition will be able to make very valuable oceanographic explorations Filchner estimates the cost of the expedition at $300 000 with one ship and $500 000 with two ships and these estimates are none too high in the opinion of other polar explorers $90 000 has already been subscribed Filchner desires to rely upon private capital alone in order to be entirely independent in his control of the expedition —Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Zeitung

A SELF-LIGHTING ELECTRIC ALARM CLOCK.

BY DR. ALFRED GRADENWITZ.

THE ingenious electrical apparatus recently designed by Prof R Dubosq at Bayeux France and pictured in the accompanying illustrations is intended to perform the function of awakening a sleeper and of lighting an electric lamp, to assist him in rising By extinguishing this lamp, a platinum wire is brought to incandescence on which any other lamp can be lighted in case the owner of the apparatus has no electric plant at his disposal

As seen in Fig 1 the apparatus consists mainly of a small wooden box with a primary battery or two pocket accumulators This box is provided on its sides with different devices viz to the left (1) the handles and disengagement device in front (2) the alarm with the index for actuating it and to the right (3) the bell mechanism with the lighting device for the platinum wire On the cover the lamp is located with its reflector and a small resistance which opposes the slight resistance of the platinum wire to the higher resistance of the incandescent lamp The apparatus comprises essentially three parts—the actuating device the disengagement device and the transmission

The actuating device on which the working of the whole mechanism depends consists simply of a slotted copper index *PP* carrying at its end a stop which can be adjusted to any point on the dial This index is so designed that the minute hand may pass over it without touching it whereas the hour hand on coming into contact with it closes the circuit The mechanism proper of the alarm clock need not be altered in any way In fact any ordinary alarm clock can be used its mechanical operation being reserved for the case of a breakdown in the electrical arrangement

The disengaging device is equally simple It consists of a double electromagnet and three levers represented in Fig 1 to the left (1) This electromagnet will act by attraction immediately on what is called the disengagement lever ' *D* which communicates first through a slot with the lever *c* which actuates the lighting circuit (represented in full lines) and secondly through a projection with the lever *C* which actuates the bell circuit (shown in dotted lines)

From the above it will be readily understood how the mechanism operates By switching in the lever *c* the circuit is interrupted at *b* and by switching in the lever *C* the other circuit is broken at *C* The switches are then brought into their proper position viz *B* into the position *B* and *e* into the position *e′* and finally the actuating index is brought into contact with the hour hand of the alarm

The inside terminals *AA′* will then be connected with the two terminals of the small battery contained in the box the electric current taking the following course From *A* to *B B B C C* to the electromagnet *E* over *F* the body of the alarm and then over the hour hand to *P K H* and *A* As the electromagnet at the same moment attracts the disengaging lever *D* the lever *c* is again brought into contact with *b* by a spring connected to it and the lighting current coming from *aa* will go directly to the lamp whereas the lever *C* becoming disengaged drops into the position *C″* leading the current through another circuit to *A′* while traversing the bell arrangement the latter does not stop ringing before the switch *B* has been brought back to its disengaging contact *B′* If now the switch *e* be put back to *e′* the lamp is extinguished and by pushing it on to *e″* there is lighted the platinum wire, the luminous intensity of which is controlled by a small rheostat, located in the cover The sleeper must obviously get up to stop the alarm

TRANSMISSION OF ELECTRIC WAVES

FROM the results of experience in wireless telegraphy in various directions and at all hours of the day and night it appears that the ether does not always possess the same power of conducting electric waves but that its conductivity varies greatly at different times The more intense the solar radiation the smaller is the conductivity of the ether Hence the prevalence of atmospheric electrical disturbances at night is due to the fact that the greater conductivity of the ether at night makes perceptible the electric waves produced by storms so distant that they cannot be detected in the daytime. For the same reason wireless dispatches can be sent greater distances at night than by day Finally it may be concluded that a wireless station of given construction does not possess any definite and constant radius of action A station which can send messages to great distances at 50 degrees north latitude may have a very restricted range in the tropics owing to the greater intensity of solar radiation

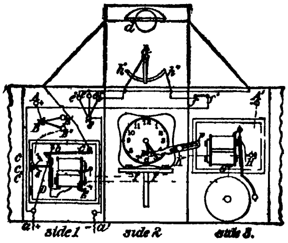


FIG 1 —CIRCUITS OF THE CLOCK

STEAM TURBINE ELECTRIC LOCOMOTIVE

AT the opening meeting of the Glasgow University Engineering Society October 28th 1909 Mr Hugh Reid managing director of the North British Locomotive Company of Glasgow in his address as honorary president of the society made public a most interesting description of the first steam turbine electric locomotive This new type of locomotive is now under construction on the Reid Ramsey system, in the works of the North British Locomotive Company

The Heilmann steam-electric locomotive built in 1894 was considered the most notable attempt to introduce independent self generating electric units that might operate over existing railway systems without necessitating any electrical equipment for the railways themselves The Reid Ramsey though a development of the Heilmann idea is said to be founded on a very different and much more practical basis

FIG 2 —AN ELECTRIC ALARM CLOCK

The sleeper must get up to stop it.

The boiler in which the steam is generated is of the ordinary locomotive type fitted with a superheater Bunkers and water tanks at both sides of the boiler carry the coal and water supplies A turbine of the impulse type with a speed of 3 000 revolutions per minute, coupled directly to a continuous current variable voltage dynamo or generator receives the steam fed from the boiler The dynamo supplies electrical energy of from 200 to 600 volts to four series wound traction motors the armatures of which are built on the four main or driving axles of the locomotive

The exhaust steam from the turbine passes into an ejector condenser and is together with the circulating condensing water delivered eventually to the hot well Owing to the fact that the steam turbine requires no internal lubrication the water of condensation is free from oil and consequently is returned from the hot well directly to the boiler by means of a feed pump

As the water evaporated by the boiler is returned to the boiler continuously the supply of water carried in the tanks is actually circulating water for condensing purposes This condensing water is circulated within practically a closed cycle by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo The cycle of the condensing water is from the tanks through the first pump then through the condenser where it becomes heated in condensing the exhaust steam then to the hot well From the hot well it passes through the second pump to the cooler situated in front of the locomotive where the full benefit of the blast of air caused by the movement of the locomotive aided by a fan is utilized for cooling the hot circulating water After passing through the cooler the water is returned to the supply tanks ready for further condensation duties

The locomotive boiler is deprived of the usual exhaust blast which induces the draft through the fire box and tubes owing to the condensation of the exhaust steam A forced draft provided by means of a small turbine fan replaces the reduced draft in the new locomotive The fan is placed within the cooler so that it will deliver hot air to the boiler fire and at the same time assist the current of air through the cooler

The small switchboard and the instruments required the controller for grouping the four motors in series—series parallel and parallel according to the draw bar pull to be exerted—and the regulator for controlling the voltage in the electrical circuit and consequently the speed of the train are all placed under the driver's platform within easy reach —American Journal of Steam and Electrical Engineering

ALEXANDER AGASSIZ, FOR MEM R S

ALTHOUGH the great American oceanographer had reached the age of seventy five few of his friends were prepared to hear of his death which appears to have taken place somewhat suddenly on board the S S Adriatic on March 28th while on a voyage back to the United States

The distinguished son of a famous father Alexander Agassiz was born in Switzerland but naturalized in America yet so cosmopolitan was he in his tastes and habits that if ever an individual deserved the title of a citizen of the world he was the man Up to the age of thirteen he was educated in his native land but proceeding to the United States in 1848 he went to the Harvard University where as a student in chemistry and engineering he obtained his degree of B Sc at the age of twenty two After spending a short time as a member of the United States Geological Survey young Agassiz became a mining expert and so successful was he in this profession that acquiring possession of valuable properties in the Lake Superior region he rapidly made a very large fortune in connection with the copper mines

The love of natural history studies however which he inherited from his father soon made itself felt at first he assisted his father as curator of the Museum of Comparative Zoology at Harvard As his wealth increased he was able to benefit that institution not only by specimens collected during his extensive travels and by defraying the cost of many expensive publications but also by gifts of money up to 100 000l After the death of his father he acted as curator of the museum for eleven years Beginning with the study of marine ichthyology he subsequently came to be acknowledged as a great authority on the Echinodermata so that on the return of the Challenger expedition he was asked to undertake the report of the Echini collected during the voyage

But the work for which Alexander Agassiz will be chiefly remembered was that which during nearly forty years he carried on at his own expense in connection with oceanography. The United States government with the greatest liberality and consideration for the interests of science allowed him from time to time the use of their survey vessels the captains of which were instructed to place themselves virtually under the orders of Agassiz himself. The naturalist aided by a staff selected and paid by himself carried on soundings and dredgings in every part of the globe special attention being devoted to the study of coral reefs. Beginning in 18[illegible] with the study of the Gulf of Mexico the Caribbean Sea and the Atlantic coast of America Agassiz continued his work in 1880 by investigating the surface fauna of the Gulf Stream. Besides working out the details derived from the study of collections made during these voyages the results of which were published in connection with the Harvard Museum of Comparative Zoology Agassiz wrote a well-illustrated account of his work The Three Voyages of the Blake, in two volumes.

In 1891 Agassiz transferred his attention to the western shores of the United States and Central America investigating the seas around the Sandwich Islands and paying special attention to the coral reefs there between 18[illegible] and 1891. His explorations were extended during 18[illegible] to the Great Barrier Reef of Australia and in 1898 to the Fiji Islands. In 1899 and 1900 he was able to undertake a cruise among the various groups of coral islands lying between San Francisco and Japan. In 1901-2 Agassiz commenced his study of the Indian Ocean paying especial attention to the Maldive Islands and their surroundings, and in order to complete the examination of portions of the Pacific that he had not already visited he devoted the years 1904-5 to a cruise among the important island groups of the eastern half of the Pacific Ocean.

The intervals between his several voyages were occupied by Agassiz in the study of his enormous collections and the preparation of memoirs dealing with the results obtained. These were issued regardless of expense as to their illustration in the publications of the Boston Society's Museum of Comparative Zoology. No fewer than thirty volumes of memoirs and fifty-three volumes of bulletins are devoted to the results obtained from the study of these collections by Agassiz and the various specialists who assisted him. His own favorite place of work was Paris where rooms were always allotted to him in the Museum of Natural History and he had the fullest access to scientific libraries.

Of the value and importance of the results of these voyages it is impossible to speak too highly. Perhaps the most striking of the conclusions arrived at by him are those relating to great movements which have taken place in the bed of the Pacific in comparatively recent geological times. This is evidenced by the numerous upraised coral reefs which following Dana he described; in many of these the limestone rock now at elevations of 1 000 feet and upward has been more or less completely converted into dolomite.

It is not necessary in face of the above statement of facts to add that Agassiz was a man of indomitable energy. He thought as little of crossing the Atlantic as we do of crossing the Thames and death met him at last while still on the move. Of his courage a remarkable example is told concerning an altercation he had with a military officer in a crowded restaurant in Germany, on that occasion he did not hesitate to resent an insult by a blow, though fortunately any serious result from the rash act was prevented by the interposition of a number of judicious friends of the officer aided by American and English visitors who were present. In early life Alexander Agassiz exhibited something of the dogmatic habit of mind that distinguished his illustrious father but mellowed by age and constant intercourse with other men he became in after-life strikingly open minded and ready to listen to arguments even those that told against his most cherished convictions. Those who were privileged to enjoy his friendship in his later life knew him as a man of ardent enthusiasm restless energy and charming bonhomie but also as one patient in discussion and always ready to listen to facts and reasonings from whatever quarter they came. His generosity was unbounded and he was always ready to place his abundant materials at the service of young men who were qualified and willing to engage in their study.

In every scientific circle of Europe as well as in those of America Alexander Agassiz was well known and in all of them his loss will be deeply mourned. In France he received the Légion d'Honneur and in Germany the Order of Merit. In this country he was for many years a Foreign Member of the Royal Society. Only last year the Royal Geographical Society awarded him the Victoria research medal and we may fitly conclude this notice with the verdict of the president in announcing the award a verdict in the justice of which all must agree. "He has done more for oceanographical research than any other single individual."

John W Judd in Nature

PROBLEMS IN MARINE CONSTRUCTION.*

PROCEEDINGS OF THE INSTITUTION OF NAVAL ARCHITECTS.

The current problems of most interest to those engaged in the branches of science associated with marine construction are usually brought into high relief at the annual meeting of the Institution of Naval Architects and in the present year this has been particularly the case. This is as it should be because the Institution which is to celebrate its jubilee some three months hence is the nerve center of the profession in this country if not indeed in the world. The action of the Council in recent years in insuring a high standard of attainment on the part of the new members elected is therefore to be commended. We are glad also that it has been decided to apply for a Royal Charter of Incorporation because this will not only confer direct advantage on the Institution in the matter of its finance and property but will add a well-merited dignity. This distinction is the more justifiable in view of the direct service rendered to the nation not only by the Institution collectively but by the component members. Mr Froude was perfectly accurate when in moving the resolution in favor of the application for a Royal Charter he stated that at the time the Institution was first organized naval architecture in Britain was not on a scientific basis and that we had to look to France for inspiration and example. The literature of our neighbors and the marvelous success of their ships were in some measure a reproach. But so soon as Scott Russell Sir Edward Reed Sir Nathaniel Barnaby and other originators of the Institution perfected their organization there was created an aspiration to excel in scientific shipbuilding with a medium for interchange of views which at once placed the industry on a more sound foundation. The result has been that the British navy has since led the way so far at least as design and construction of warships is concerned whereas in the merchant marine we have established a position of superiority in the efficiency of high-speed merchant steamers and in the economy of cargo-carrying ships as well as in that great extent of shipping which is more or less consequent upon our insular position and upon the extent of our colonial possessions.

The meetings this year have shown that in the grasp of scientific problems the Institution maintains its high standard. This is reflected in the complete report we publish in this issue of the discussion on the propeller problem. The discussion is almost entirely consequent upon experimental research upon Froude's lines and in this respect there is rejoicing that the jubilee meeting should be signalized by the formal opening of the National Experimental Tank at Bushy where experimental research will be carried on continuously without interference by the commercial element and without being subject to the claims of education. We have already given expression to the national sentiment with reference to the munificence of Mr Yarrow's action in providing funds for the construction of this most important accessory to the National Physical Laboratory and his practical interest in the whole question. We are glad that there will be no lack of funds for the maintenance of the property and for the prosecution of research. The Governing Body of the National Physical Laboratory is sufficiently representative to insure that the maximum utility shall be derived from the tank and the Executive Committee of the tank have acted wisely in accepting Sir Philip Watts's guidance in the appointment of a superintendent. We have no doubt that good will result in view of Mr G S Baker's personal attainments and his work at the Admiralty. The composition too of the Executive Committee which was referred to in Dr Glazebrook's paper published in last week's issue is of the first importance because the work of experimental research calls for very special qualifications not only on the part of the officer principally responsible but also on that of the guiding executive body. Broad knowledge and wide sympathies are essentials. There must be the true spirit of imagination and yet of more importance is the characteristic of concentration. On the one hand it is important that every element that may conduce to success must be regarded in proportion to its potentialities. Proposals must be considered even although they may be contrary to preconceived ideas or to current practice. There should on the other hand be the faculty to measure the influence of variants and to assess their due proportion in arriving at conclusions. Thus imagination must play a large part in determining the lines of investigation but in detail work there must undoubtedly be rigid exclusion of everything excepting absolutely proved results. There is however sufficient example for the student of character in the history of engineering alone and without attempting to exhaust the list reference may be made to James Watt Robert Napier John Elder and to Robert Froude whose work it will be found combined that recognition of possibilities which belongs to imagination and that strict regard for accuracy of detail which is so essential in scientific deduction.

We have not made reference to the quality of patience as a requisite in overcoming the monotonous influence of repetition work which may always be classed more or less as drudgery. In the paper by Mr Luke this quality as well as the others above mentioned must be inferred because we have here the results of some 2 000 experiments made with one model set out with brevity and lucid explanation and followed by deductions of considerable influence from the point of view of practical design. Here we may interject the remark that Mr Luke's firm—Messrs John Brown & Co Limited—deserve credit for their public-spirited action in putting these results at the disposal of the profession, because they have been evolved at their own tank as the result of an expenditure of much time and money; this credit is the greater when we recall that they have handsomely subscribed to the maintenance of the National Experimental Tank. Mr Luke in his paper followed the lines of Mr Froude the pioneer in such investigations but whereas the results formerly given to the Institution showed how the general shape affects the wake factor and thrust deduction in the case of many different models Mr Luke has taken one model representative of the average type of twin-screw steamer so that he has been able to eliminate every variant excepting those which affect the particular issue. The deductions made relate most directly to the problems of the propeller in its position relative to the skin of the ship the direction of rotation size etc. As this is one of the elements in ship propulsion regarding which there is less definite information than on any other we commend the contributions made not only by Mr Luke but by Prof Henderson of the Royal Naval College at Greenwich and Mr T B Abell also of the Royal Corps of Naval Constructors. A long and suggestive discussion followed the reading of these three papers.

Mr Luke seems to have given food for reflection as to whether the inward or outward turning screw is the more efficient. Mr D W Taylor of the United States Navy Experimental Tank who has also done valuable experimental research work on propellers also combats the general idea that the inward turning screw is preferable. Equally significant are Mr Archibald Denny's observations on this question as he also combines a knowledge of the results of tank work with those given by trials of the completed ship. Mr Denny gave results of trials with the ship on the measured mile where the only variant was the direction of rotation of the screws when the outward turning screws gave superior efficiency. Very significant also was the recognition of the possibility of tank experiments differing in their results from those attained in the actual ship on the measured mile with respect at all events to propellers. The possessors of tanks are however always careful thoroughly to test their ships and to compare the data with those evolved by the model experiments.

This of course, must not be accepted in any way in disparagement of the value of experimental tank work in its relation to practical shipbuilding. As a rule in tanks owned by private firms the current work is so extensive that general experimental research cannot be undertaken and as a consequence, the National Experimental Tank will be of great service. By "general experimental research" we mean problems in principles rather than in details. In such cases it is of the utmost importance that each series of experiments should have but one essential variant, as in Mr. Luke's researches, and consequently a comsiderable amount of time must be absorbed in one set In a previous article on the general work of the tank* we showed that the work of experimenting, on ship models at any rate, followed Newton's "principle of similitude," rediscovered by Froude and called the law of comparison The broad principles are therefore simple but have to be used with care The practical application of the principles as in many other forms of work in physical laboratories makes it necessary to adopt many mechanical devices to insure accurate records, as a consequence, a large volume of the work of collating results, and reducing them to comparative standards is tedious This raises the question as to whether experimental tanks are necessary acquisitions in educational institutions or whether the National Tank cannot in itself satisfy all requirements in this direction The number of experimental officers required for the direction of tanks in any country must be small because such an apparatus is an expensive accessory even to a large shipbuilding works Is it worth involving large expenditure to have such tanks at educational establishments in order to educate a large number of students along specialized lines which must terminate in the great majority of cases with the college course? Those who have the characteristics of the experimenter—the enthusiasm for work and the desire to prosecute it—might very well join Dr Glazebrook's staff in order to gain at Bushy an intimate knowledge of the higher experimental work of the tank Such specially trained men are only necessary for the direction of affairs, the collation of results may be done by those who have not had a special college training This however is too large a question and belongs to the wide subject of the equipment of technical institutions

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* Engineering.

The Institution of Naval Architects has however judiciously combined the scientific with the practical and while the discussion on experimental research particularly propeller design occupied a prominent place in the recent session there were many other topics dealt with of direct practical value The subject of the design of battleships raised by Admiral Bacon is too large to be dealt with in a general article and moreover it cannot be said that any addition was made during the discussion to the general sum of knowledge of the principles on which the Admiralty have proceeded in evolving their designs as laid down in general and clear terms by the author of the paper The Admiralty and naval shipbuilders were well represented at the meeting but it would seem that secrecy sealed their lips The turbine question naturally found its way even into this discussion and Prof Biles put the matter of the speed of battleships with his usual perspicuity He very properly claimed that machinery was entitled to a certain proportion of the total weight and Mr Parsons by reason of the higher efficiency of his system had enabled the dreadnoughts to be of at least 2 knots greater speed than vessels with ordinary reciprocating engines without involving any addition to weight

The turbine however came into greater prominence by reason of the papers which advocated some form of gear between the high speed turbine and the propeller in order that both should run at the speeds which are found most efficient under given conditions So far as warship work is concerned the propeller coefficient of about 0 6 now realized in most cases does not seem to justify any misgiving as to the collective efficiency of the machinery between the boiler and the propeller In the case of low speed vessels however there should be room for the interposition of speed reducing gear The electrical engineers were strong in their claim for the electrical gear even for warships but it seems doubtful with a transmission loss of from 10 to 15 per cent if the adaptability of the system justifies its preferment There is the difficulty of easily varying the speed but Mr Archibald Denny brushed this aside by contending that by having many generating units it would be possible to insure more variation by stopping one or more of the generators in order to suit the particular change of ship speed desired With low speed however the motors would be less efficient and there would always be the difficulty of sea spraying if not also of the high saline density of the moistened air at sea affecting injuriously the insulation Mechanical gear on the other hand offers great attractions It is proved that the loss need not be more than 1¼ per cent a result which has been attained alike by Mr Parsons's and the Westinghouse system The continuance of the prejudice against gearing is in its way characteristic of the trend of thought of engineers generally but it is forgotten that there has been great development in the quality of metals a point not mentioned during the discussion—while there is greater precision in manufacture De Laval has for twenty years had very successful results notwithstanding the great reduction in speed which he adopts

The paper read by Mr Parsons is of enormous significance as in the 10 knot steamer Vespasian he has under exactly the same conditions excepting only the use of turbines and gear instead of triple expansion engines increased the speed by one mile per hour owing to the higher efficiency of the turbine and has reduced the water consumption and consequently the coal consumption by nearly 20 per cent The weight of the reciprocating machinery was 100 tons as compared with 75 tons for the new installation We have thus a very considerable addition to the amount of cargo which may be carried a saving in coal and oil, in engine room staff and in upkeep In respect to this latter item there is the important advantage that the working steam pressure being very much lower than with modern economical engines the first cost and upkeep of boilers and steam connections will be considerably less When the Vespasian goes into service the results of her voyage when compared with the last voyage made with the renovated triple expansion engines will be watched with very considerable interest as the system offers the advantage of the turbine system and may indeed serve for moderate speed passenger vessels where the turbine alone may not be desirable in view of the speed developed

The extreme simplicity of the system was commended Mr Parsons in replying to the discussion, referred to the cradle balanced frame for the pinion in the Westinghouse gear as unnecessary because the pinion would adjust itself automatically distributing half the tangential push between the right and left hand teeth on each side Neither De Laval nor he uses such a balancing arrangement and were it required he prefers giving wheels and pinions slight rotary elasticity on the shaft

The papers read on the application of gasoline motors to lifeboats and fishing and commercial vessels were also interesting Mr Barnett in the design of his motor lifeboats has displayed very great ingenuity and his paper is most suggestive Mr Linton Hope reviewed the situation generally in regard to fishing and commercial vessels showing that for sailing boats the internal combustion engine could be installed for about one half the cost of steam power and the result was not only a considerable reduction in the crew but what was even more important arrival in port in advance of the steam trawler and on the top of the market The earnings of each member of the crew of a motor boat were said to be nearly 50 per cent more than in the steam drifter As regards the utility of the internal combustion motor for use in commercial vessels there is slow but steady development in this country although the results on Continental internal waters seem to justify a greater rate of progress Mr Linton Hope suggests that the adaptation of the internal combustion motor to existing wooden vessels may increase the number of voyages per annum to 30 per cent which is a high estimate but we look rather to the building of a new type of craft more suited to propulsion by this type of motor Good results will accrue if care be taken in making the power adequate for the service These and other similar practical suggestions were laid before the Institution and in most instances gave rise to discussions so that the proceedings were certainly well up to the average of those of preceding years

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* See Engineering vol lxxxi pag 641

IMPURE WATER AND ITS EFFECT ON FISH

Since fishes are confined to water as their natural habitat and since water strictly pure scarcely exists naturally upon the earth they live habitually in water containing a certain amount of foreign substances in solution—in other words in impure water There is also nearly always some foreign matter held mechanically Since these so called impurities may vary greatly in kind and degree the study of the reactions which take place between fishes and impure waters of various nature cannot fail to be both of theoretical interest and practical importance Hence it is that the United States Bureau of Fisheries has published from the pen of Mr M C Marsh some Notes on the Dissolved Content of Water in its Effect upon Fishes

It is profitable to inquire first whether these impurities are merely incidental to the life of the fish as they are to the water or are essential and necessary That air dissolved in the water is necessary to support fishes is a matter of common knowledge and observation for they die quickly if the water is not aerated It may likewise readily be shown by experiment that water containing dissolved air alone is not sufficient even though plenty of food is supplied For this purpose, 5 liters of water were distilled through glass apparatus Contrary to what seems the general impression distilled water has considerable air dissolved even immediately after the distillation A portion of this water from the receiving flask was tested for oxygen during the distillation and contained at 15 deg C 5 48 cubic centimeters of oxygen per liter Twelve quinnat salmon fry were placed in the 5 liters of water in a glass jar, with a current of air in small bubbles constantly passing to the bottom of the jar and bubbling up through the water A control was set in exactly the same way, save that Potomac tap water was used instead of distilled water Three and one-half hours after the beginning of the experiment, the water in each jar being at 14 deg C, oxygen was determined The Potomac sample held 7 25 cubic centimeters per liter, the distilled sample 7 09 cubic centimeters, each therefore almost air-saturated with oxygen. In the distilled water, after 24 hours, 2 fry were dead, after 27 hours 3 fry, after 37½ hours all were dead All the fry in the control remained alive During the experiment the aeration of the control was never greater than that of the distilled sample and was usually less

Rain water was tried in substantially the same way and with mummichogs sunfish perch and trout with the same result The mummichogs were the most resistant living 41 hours

One is led to conclude from this that foreign matter other than dissolved air is a necessary accompaniment of water that supports fish life and that water can be too pure for fishes The law is probably of wide application for low forms of life are known to die readily in distilled water It is natural to infer also that death is brought about in these cases by some osmotic reactions through the gills which bring the blood known to contain various salts essential to the life of the fish into intimate relation with the water It is an assumption open to several objections to explain the death as due to the dissolving out of salts or other substances from the blood Certain obscure poisonous products are believed to be generated in the distillation of water and conceivably even in rain water these may have a toxic action on fish If so their toxicity is neutralized by contact with many simple substances It is known that some toxic principles in ordinary water are thus neutralized as will appear later

For practical fish cultural purposes it may be assumed that a certain minimum of dissolved solids is necessary to water before it is suitable for fishes and no doubt there is also a maximum which should not be exceeded though a wide adaptability must exist as some fishes can frequent both fresh and salt water Where either of these limits lies cannot be at present stated Of course natural waters which contain fishes furnish the safe conditions both as to quantity and quality of these necessary impurities which are common substances—carbonates sulphates chlorids in combination with calcium, magnesium sodium and other common metals Potomac water had in October 1905, 240 parts per million, the spring water at the White Sulphur Springs (W Va) hatchery had in February 1906 484 parts Neither of these amounts is objectionable so far as known Many waters have a total solid content below 0 parts per million and fishes inhabit waters containing no more than 20 It is perhaps true that water with much less solid matter than this would support fishes It would be interesting to find if possible some natural water fatal to fishes solely on account of its high purity

It seems that these considerations about the quantity of dissolved solids may become of some practical importance when fish are transferred from one water to another as from one high in total solids to one low in total solids Possibly one water may differ so greatly from another in this respect alone that a gradual transfer by slowly mixing the two waters is advisable in order that the fish may adjust itself from the one to the other Trout for instance do not always thrive after transfer even when both waters seem admirably adapted to the trout already in them

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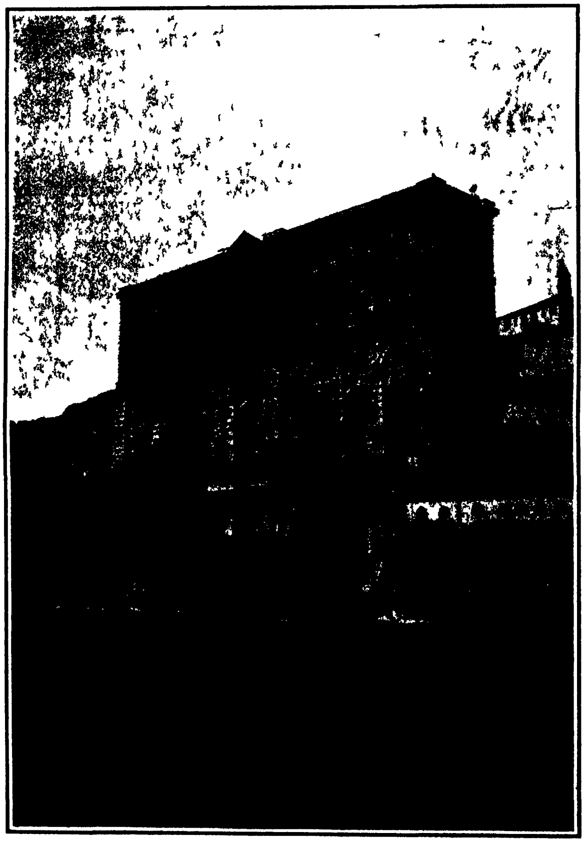
An interesting preliminary notice by Mr P A Curry of the results obtained in the research of the upper air above the Blue Hill area during the rainy season of 1909 is published in the Cairo Scientific Journal for October last The main object was to find the direction and velocity of the wind at different heights above Roseires by the use of small pilot balloons of which seventy nine were released The surface wind, which was slightly west to south veered to south west at 1 500 meters at 3 000 meters northeast winds were somewhat predominant veering to slightly north of east at 3 700 meters From that altitude it was very constant in direction to 6 000 meters after which it backed slightly to northeast at 9 000 meters then veering again to east at 12 000 meters One balloon which rose above this showed a due east wind at 13 000 meters and 14 000 meters veering to east southeast at 18 000 meters Up to 3 000 meters the velocity averaged little more than 5 meters per second increasing to 10 meters per second at 6 000 meters it then decreased to 8 meters per second at 7 000 meters and remained fairly steady up to 10 000 meters Above this altitude the velocity increased rapidly The results show a fairly steady circulation whether rain falls or not and the limiting height of the upper easterly drift does not decrease on dry days, as was found to be the case in Abyssinia.

THE OCEANOGRAPHIC MUSEUM AT MONACO.

A DESCRIPTION OF THE NEW BUILDING.

The inauguration of the Oceanographic Museum at Monaco took place on March 28th in the presence of representatives of the governments and navies of France Germany Italy Spain and Portugal and a great gathering of men of science of all nations who were invited by the Prince of Monaco and entertained as his guests in his ancient palace Monaco and in various hotels in Monte Carlo The inaugural *fetes* lasted for four days they were planned on a scale of magnificence rarely attempted and drew upon the resources of art in a manner which we believe has never been paralleled It would almost appear as if the design were to show that science no less than pleasure was a fitting theme for the exercise of art as exemplified in painting poetry and music and that in any case the dedication of a great international scientific institution provided by the princely munificence of an individual was no everyday matter to be passed by unnoticed save by the specialists immediately concerned

The inauguration was an interesting function which could not fail to impress the most regardless pleasure seeker in the gayest haunt of the Côte d Azur with the thought that science even in perhaps its least known department was a thing of high importance To us the fact that someone had blundered and no admiral of the British fleet was there to join the high German French and Italian officers in offering a tribute to the scientific study of the sea was a cause of humiliation It is little short of a disgrace that the country in which modern oceanography was created and the navy the Challenger of which revealed the wonders of the ocean as a whole were brought to the attention of the gathering only by the Prince s generous recognition in his inaugural address of British preeminence in oceanographical research and in the name of the ship engraved on the façade of the new building We know of course that the breach of international good manners was due to no intention on the part of the King or of the Prime Minister to inflict a slight upon a noble enterprise but the effect was none the less deplorable and on behalf of the British scientific public we desire to give expression to this feeling in the most emphatic way The official representation of the Royal Society the Royal Society of Edinburgh the Royal Geographical Society and the Challenger Society showed at least the good will of British men of science



THE OCEANOGRAPHIC MUSEUM OF MONACO

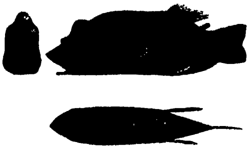
It seems more appropriate to occupy this article with a short description of the museum itself than with details of the formal speeches at the ceremonial inauguration the performance at the opera the pageant in the harbor symbolizing the landing of Hercules mythical founder of Monaco in a blaze of fireworks and the concluding reception by the Prince in the palace One evening was devoted to a series of lantern demonstrations by Lieut Bourrée which proved of extraordinary interest on account of the kinematograph representation of the routine of work on the Princesse Alice in handling the various oceanographical instruments and appliances at sea

The Prince of Monaco has devoted an increasing amount of time to deep sea investigation since he commenced his observations on the Gulf Stream in the sailing yacht Hirondelle in 1885 and as a result of his work in that vessel in the auxiliary steam yacht Princesse Alice and in his present splendid vessel Princesse Alice II he had accumulated by 1898 so large a collection of natural history specimens that he resolved to build a museum in which to house them On April 25th 1899 the foundation stone was laid on the southern face of the cliff which bounds the peninsula of Monaco and the great building designed by M Delefortrie has now been completed and equipped and was formally inaugurated on March 28th this year The first object has been greatly enlarged and the Oceanographic Museum as it is established to day contains more than the nucleus of a collection gathered from all investigators of all the oceans illustrative of the whole science of oceanography On the face of the cliff the foundations of the museum are almost at the level of the sea Two stories are built facing the sea with the rock as their rear wall and the third story is on the level of the rock forming the ground floor of the main frontage which faces north The material is the extremely fine grained white limestone of La Turbie quarries on the mountains behind Monaco

The ground plan of the principal floor includes a central hall twenty meters square with a wing on each side forty meters long by fifteen wide the whole frontage being a hundred meters The decoration of the front of the building includes representations in relief of deep sea invertebrates and fish and the whole is crowned by the Prince s arms and a gigantic albatross and sea eagle The names of the Challenger Talisman Valdivia Hirondelle Princesse Alice and other ships which have become famous in the annals of oceanography are boldly carved along the front Two great groups of symbolic statuary flanking the immense window of the landing on the upper floor represent Truth unveiling the forces of the world to science and Progress coming to the rescue of humanity The roof of the central part of the building eighty seven meters above the sea forms a meteorological observatory and the main roof five meters lower forms an immense terrace measuring a hundred meters by fifteen meters The entrance hall floored with mosaics representing the Princesse Alice at sea surrounded by trophies of deep sea fish contains the two great stone staircases leading to the upper floor and unobtrusive doors leading to the stairs by which the director s room library laboratories workshops and aquarium on the lower floors are reached It opens into a large square hall lighted at night by an immense pendant representing a medusa the lights in which are so disposed as to bring out the anatomy with extraordinary distinctness Four smaller lights are incased in models of radiolaria very exactly reproduced

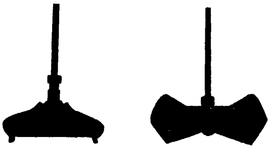
A marble statue of the Prince in yachting costume leaning on the rail of his yacht occupies the center of the hall this remarkably fine portrait executed by M D Puech was presented by a number of the sovereigns of Europe and other admirers of the Prince Great doors to right and left open into the two wings of the building each forming a lofty hall lighted by windows along each side which may be shaded or darkened as required The western hall is at present fitted as a meeting room for functions and here the ceremony of inauguration and the banquet took place The platform at the west end is surmounted by an immense painting showing the slaty blue ocean heaved into a long swell with the white form of the Princesse Alice in the background Electric lights in clusters representing seaweeds and marine animals hang from the roof and the ceiling is frescoed with views of the sea and ships.

The eastern hall is occupied by a collection of ocean graphic apparatus and specimens of marine zool gy arranged in a provisional way The collection ncludes several whale skeletons Arctic and Antarc ic seals models of fish and a vast number of specimens in preservatives The labels are written in French English and German and give sufficient details of the exhibits to enable a visitor to appreciate the remarkable character of many of the specimens



A FISH WITH TELESCOPIC EYES

Front side, and bottom views



SOUNDING APPARATUS

Collecting sand from the sea bottom

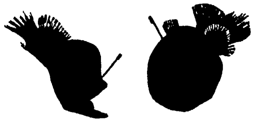
Open while descending

On the upper floor the central hall contains models of the Princesse Alice I and the Princesse Alice I showing the arrangements for sounding and for working the zoological apparatus There is a whale boat exactly as used by the modern whaler with the gun throwing the explosive harpoon at the bow and the full equipment of harpoons lines and lances The eastern hall on this floor will ultimately be devoted to physical oceanography and to deep sea apparatus Here there is a great collection of dredges tow nets showing the various devices for opening and closing at a given depth the deep sea traps with which the Prince has revolutionized the method of obtaining animals from the greatest depths and many other appliances either as used or in the form of models At present a part of the room is occupied by a collection of specimens illustrating marine industries such as fishing sponge gathering collecting pearls as well as the use of pearl shell coral tortoise shell and similar products The western hall is not yet arranged but serves at present for classifying the various collections of mollusks bottom samples etc which are being dealt with

The purpose of the museum is to have all the principal collections in duplicate one set for exhibition the other for purposes of study The aquariums have already been utilized for the purpose of physiological and biological researches and the little steam vessel Eider is available for students to familiarize themselves with the methods of practical oceanography This little steamer of twenty tons displacement and sixty horse-power is fitted for working to a depth of 2 000 meters and is being used for the detailed study of the portion of the Mediterranean in the immediate vicinity of the museum

The Oceanographic Museum under the direction of Dr Richard to whose admirable description of the building and the collections we are much indebted is only one part of the Oceanographic Institute which the enlightened munificence of the Prince of Monaco has called into existence With the object of arousing interest in scientific marine studies in France the Prince started a series of lectures at the Sorbonne in 1903 and in 1906 he gave perpetuity to these courses of lectures by purchasing land which was much wanted for the extension of the university buildings and presenting it to the French nation together with a building specially devoted to university instruction in oceanography This building is now nearing completion and will probably be opened in the present year or at latest in 1911 Needless to say the university and the French government accepted the gift with lively gratitude Three professorships have been created in connection with it M A Berget having the chair of physical oceanography M L Joubin that of biological oceanography and Dr P Portier that of the physiology of marine life The administrative council under the presidency of the Prince includes the names of several highly distinguished Frenchmen but the committee for perfecting the institute is international and includes representative oceanographers of all countries Great Britain being represented by Sir John Murray Dr W S Bruce and Mr J Y Buchanan

During the course of the Monaco gathering four important international committees met each with the Prince as chairman and considering how his time was filled with State ceremonies and hospitality it is only extraordinary enthusiasm as well as most unusual physical strength that enabled him to preside hour after hour with unfailing courtesy and constant tact over proceedings conducted in three languages The committees were those for perfecting the Oceanographic Institute for research in the Mediterranean in which we understand that the Italian government will take an active part for research in the Atlantic where international co-operation is hoped for to be organized at a future meeting to be convened by the Oceanographical Institute in Paris and finally for the preparation of a new edition of the Prince s bathymetrical chart of the oceans It was decided in the new edition of this chart to suppress the indication of the nature of the bottom which is often fallacious to add contour lines and certain physical features on the land and to revise the terminology



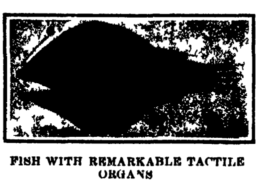
FISH WITH REMARKABLE TACTILE ORGANS.

By his researches the Prince of Monaco has won for himself a place in the foremost rank of men of science and by enshrining the results in the monumental buildings at Monaco and Paris he has invested his labors with permanent value for all time His modesty and earnestness greatly impressed all those who took part in the proceedings here described and if a proof of this is demanded it is enough to say that no one in authority mentioned the cost of the works which is usually a prominent feature in the description of any benefactions —Nature

PRINCE ALBERT OF MONACO IN THE UNIFORM OF THE ACADÉMIE DES SCIENCES OF PARIS

Crystals of the same substance vary greatly in their sensitiveness and in the treatment they should receive to obtain the best results for detecting electromagnetic waves It would appear that generally to obtain the most sensitive results there should be a very slight contact between the substances employed but if a crystal can be found sensitive under a fairly hard pressure the adjustment remains constant for a considerable time According to Electrical Engineering Mr S R Drayton the chief operator on the Trinidad government stations finds that of all the contact detectors at present tried the silicon is the most reliable Using no battery for ordinary working and a fairly hard pressure this detector remains in adjustment for several weeks if it be short-circuited when transmitting and a knock does not throw it out To test if the detector be in adjustment a fraction of a volt is switched on to the detector and telephone receiver in series the click in the telephone tells whether the adjustment is correct

The Baden State Railways after investigation decided that the hearing of locomotive engineers is affected by vibrations of the engine communicated from the floor on which the men stand To prevent this cocoanut mats are to be provided both for engine man and fireman



FISH WITH REMARKABLE TACTILE ORGANS

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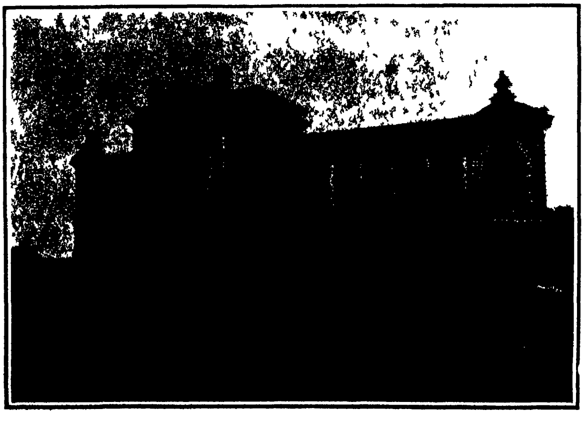

THE MUSEUM OF MONACO

OBSERVATIONS MADE AT THE YERKES OBSERVATORY, 1902-1909.[*]

BY E. E. BARNARD OF THE YERKES OBSERVATORY.

One fact that is evident in the observations made at Yerkes Observatory is that the auroral arch varies greatly in size For if we assume that it is the segment of a circle whose center is essentially stationary with respect to the earth it must fluctuate as much as a diameter of itself in size The arch sometimes extends half way to the celestial pole and at other times its entire extent is beneath the horizon as indicated by the streamers coming up from below the horizon

Perhaps with the exception of the narrow ray a degree in width and eighty degrees or more in length which was seen rising from the west horizon on August 21st 190[illegible] no new phenomena have been seen

The streamers which spring from the arch as a base and which always have a decided lateral motion and last for a minute or so only almost always move to the west On several occasions however I have seen them divide the arch with respect to their motion so that the ones to the west moved west and those to the east moved east This is very rare The motion is about 2 deg in one minute (and not 2 minutes to the degree as I stated in Astrophysical Journal 16 14) I have wished to determine this motion more accurately but we have had so few ray producing auroras in late years and the rays are so transient that I have not been able to do so It would be interesting to know if this motion is constant in a streamer and for all streamers

The pulsating bright masses that usually appear in the northeast or northwest but which are sometimes seen under the pole are among the most interesting phenomena They are sometimes present when there are no other evidences of an aurora

In the auroras seen here there is comparatively little in the way of color Referring again to the great aurora of April 16th 188[illegible] which I saw at Nashville Tenn there were magnificent brilliant crimson curtains in the west and brilliant colors in other parts of the sky But as seen from the Yerkes Observatory in the past ten or twelve years there have not appeared any such striking colors [This was written before the great aurora of October 18th 1909]

In some of the auroras seen here there was a double arch one several degrees higher than the other

Extracts from my notes now follow in continuation of those in the paper already referred to Time of the ninetieth meridian (6 h 0 m slow of Greenwich mean time) is used throughout

1902

November 2[illegible]rd [illegible] h 0 m Faint auroral light in northern horizon 7 h 20 m Strong auroral arch very low Top of brightness half way to β Ursae Majoris Dark under arch No decided streamers but bases of streamers moving to left 8 h 0 m The aurora had almost died out There was still a feeble arch 1[illegible] h 0 m There was still a feeble glow

1903

October 30th At 1[illegible] h 0 m a magnificent aurora was in progress Mr Sullivan says that there had been an arch not conspicuous from early in the night and that it had culminated in a great display at 15 h 0 m I first saw it at 1[illegible] h 30 m The whole north was full of great streamers and rapid pulsations were fluttering all over the sky The greater part of the heavens especially north was full of hazy light and masses of streaky brilliancy were conspicuous at different points These streaks ran toward the north The streamers seemed to converge toward the zenith where frequently masses of curved and irregular light appeared fluctuating brightly and then drifting to the south The fluctuations extended down to and below Orion The streamers were broad—a few brilliant ones were narrow They did not make much inclination to the horizon except to the northeast and northwest and at their upper parts they seemed to diffuse toward the zenith as if struck by a wind For a certain height the streamers were straight then they seemed to lose their force and become subject to driftings and irregularities The ascending pulsations came from the north not in arch form exactly They would go to the zenith and beyond with extreme rapidity There were several waves a second but the irregular pulsations would last only 1/10 second There was frequently a good deal of red and a tendency of the streamers to form curtains But there was no definite arch It was diffused and extended 10 deg or 15 deg high The sky except overhead and north was more or less covered with smeary clouds especially from Orion south Though these were illuminated when the light was strongest they did not show the effect of the pulsations which seemed to pass by them in waves showing that the pulsations were beyond them There were a few streaky clouds in the north below the pole I could not be positive that there was any of the auroral light this side of them Several bright streamers were occulted by these clouds and everything seemed to be beyond the clouds The activity extended nearly from east to west through the north At any one time the activity would be confined to either the northwest or northeast

The streamers to the west of the pole moved west about 2 deg a minute those to the east moved to the east I watched this carefully to see where the line of demarkation occurred Usually here the summit of the arch is from 1[illegible] deg to 20 deg east of north and one would suppose that there would be a stationary point for these streamers at the summit of the arch Though there was no definite arch to go by I noticed that some of the streamers west of where the summit of the arch ought to be moved east as shown by the notes

November 18th 6 h 0 m A slight aurora in the north This rapidly brightened and formed an arch not very dark beneath A half hour later there were feeble efforts at streamers There were two clouds of light at about 25 deg altitude one in the northwest the other in the northeast They would brighten up then fade away

1908

May 2[illegible]th The display on this date was one of the most extraordinary that I have seen The coincidence with a great electrical storm at this time was very singular though it is probable that the two were not connected At dark there were great banks of cumulus clouds in the west and northwest These moved north and were alive with lightning—a most impressive sight

A few minutes before 9 h 0 m a great number of narrow but short brightish strips like shreds of clouds appeared overhead They formed a band across the sky from the north of west to the south of east through the zenith The individual strips were moving west with great rapidity like low clouds driven by a heavy wind and appeared to be only a few hundred feet distant From their luminosity it was at once evident that they were of an auroral nature At this time there were several great streamers in the north but the northern horizon was covered with clouds It was therefore not certain that any arch existed In some ten or fifteen minutes the strips overhead which were inclined sharply to the general direction of the band and which were ½ deg wide and 10 deg + long and had been moving westerly had now blended into a beautiful soft but bright band of cometary looking light This band was 10 deg wide and had its south edge in the zenith It extended from the east by south horizon (in clouds) to the west by north where it disappeared in the great storm clouds The sky was beautifully clear elsewhere The band though bright was perfectly transparent to the light of the stars At its ends it was apparently connected with two narrower and sharper and brighter cometary looking strips that were perhaps connected with the horizon The appearance was as if a great scroll had been flung across the sky and the end sticks to which it was attached had been dropped at an angle to the horizon These end strips were at an angle of some 20 deg to the vertical inclining to the south At 9 h 20 m between the great arch and the pole another band of short strips some 3 deg apart appeared Near the meridian these strips pointed to the pole while away from the meridian they pointed to the northwest They apparently had no decided motion These soon disappeared The great band remained bright and uniform It however was drifting very slowly to the south and at 9 h 30 m it passed through the zenith Then a parallel strip formed beside it and a few degrees north which broke into short narrow strips pointing (overhead) toward the pole but beyond the zenith to the northwest These strips were longer and narrower away from overhead They were not so well developed in the east There was little or no motion in these They fluctuated rather slowly in light and presently disappeared Shortly after 10 h the great band broke up into short strips—at a sharp angle to its length—which had a rapid westward motion Finally the band faded out overhead the two ends becoming thus disconnected The upper end of the west section drifted south so that the two would not connect if continued This kept very bright and became narrow while the east portion split laterally into several parts These shattered into short strips 10 deg or 15 deg long which had a quick short motion northerly There were apparently other strips nearer to us that moved rapidly over the first ones Their visible existence seemed to extend over about 10 deg of motion About 10 h this easterly portion drifted overhead in a fragmentary form—frequently in this appeared the moving forms At 10 h 15 m or 10 h 20 m at the time the masses of light in the zenith were fading out the sky was blotted out by the storm clouds

During all this time all over the west and northwest there was a magnificent and rapid electrical display in the clouds—so bright that it frequently blotted out everything else Just before the storm closed in a great black broad path of clouds came rapidly from the storm clouds in the west This was perfectly straight at the edges and stretched from the northern sky to the southern horizons and was uniformly 15 deg or 20 deg broad with clear sky on each side It swept overhead very rapidly—black, opaque and sharply defined As it passed I could see a few irregularities in it These were moving very rapidly along its length to the north while the whole extent of the band itself moved rapidly a little to the north of east When finally low in the east this object looked like an irregular strip of cloud It was first seen near the west horizon under the great storm clouds and was then very black and sharply defined There was no lightning in this band I doubt if it had anything to do with the aurora but its singular appearance and motion at this time were strange enough for record

At 9 h 15 m the great zone of light stretched directly through the zenith At the east it would strike the horizon 10 deg south of east In the west it passed 10 deg north of Venus Roughly it was perpendicular to the magnetic meridian It was nearly 10 deg broad—bright and transparent Its light strongly reminded one of that of a comet

There were some newspaper accounts of this singular phenomenon which seemed to have been seen at various other places In general these accounts were of no value in locating the position in the sky One newspaper had a long editorial on the subject and associated it with the zodiacal light giving a lengthy history of the latter object Of course there was no connection between the two phenomena

According to Dr Walter L Rankin of Carroll College Waukesha Wis who observed the band its summit was at an altitude of 70 deg and south of the zenith Waukesha is 29 miles north and 13 miles east of the Yerkes Observatory Taking into account the inclination of the band to the east and west line, his observation would make it about 140 miles high

A description in the Northfield (Minn) News says The peculiar aurora was in the shape of a long searchlight like a path running east and west, from 7 deg to 10 deg wide and at an elevation of 70 deg above the southern horizon ' This would place it some 4 or 5 times as high as Mr Rankin's observations It seems quite probable that it was, in its later stages, several hundred miles above the earth's surface The times were not given in any of the observations, and as it had a motion southerly, of over 5 deg while under observation here, it is probable that the results given for its height are not very trustworthy

I have thought that the remarkable nature of this display would warrant a full description, as some of the features were to me unique

In Science for July 10th, 1908 (28, 51) an account is given of what was apparently a similar display of the aurora on March 27th, 1908, by Wilmot E Ellis, of Fort Terry, N Y His confusion of this phenomenon with the zodiacal light is unwarranted The zodiacal light never exhibits any such phenomena as the above Indeed it does not show any marked changes which cannot be readily accounted for by the position of the observer or the atmospheric conditions at the time The phenomenon of March 27th was purely auroral

The night of March 27th was cloudy here, with a vivid electric storm and heavy rain the first part.

May 26th. 11 h 20 m There was a large, luminous, elongated cloud in the low northwest, whose light fluctuated rapidly. The entire sky was covered with patches and smears of luminous haze which I am sure were auroral. The night was strangely luminous. The sky was apparently covered with a luminous patchy haze In places it was streaky and sometimes long streams of it were seen Some of these were nearly as bright as the brightest part of the Milky Way With the lights out in the dome the windows looked as bright as if the sky were moonlit With the exception of the pulsating cloud in the low northwest there were no other certain evidences of an aurora But the unusual brightness of the sky and the patches and strips of luminous haze suggested that a strange auroral effect was on hand

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[*] Abstracted from the Astrophysical Journal

[†] Lack of space prevents our publishing Prof Barnard's notes in full Ed of Scientific American Supplement

September 29th 7 h 10 m Brilliant aurora seen through breaks in clouds all over the north northeast and northwest Some effort at streamers 11 h 10 m The aurora had been very active with streamers and fluctuating patches of light At about 8 h 30 m it was very brilliant The sky in the north looked like daylight The illumination extended a great distance east and west and the whole northern sky as high as the pole was bright but there was not much activity It got less bright and broke up into patches and became very active with streamers that reached higher than the pole If any arch existed it was lost in the broken clouds which covered the sky more or less all the time Patches or areas of light would ascend to great altitudes and then die out At this time (11 h 10 m) the light had almost died out but there were some streamers The sky was pretty well covered with clouds 12 h 0 m Some streamers and broken masses Clouds 13 h 0 m Less bright Clouds

1909

January 1st 15 h 40 m Streamers from behind clouds in the north—the first aurora I had seen for a long time It seemed to be quite active

January 24th 12 h 0 m A bright aurora all along the northern horizon among broken clouds Not active First saw it at 11 h 45 m—it was not visible an hour earlier 13 h 0 m Aurora visible as a bright streak along the horizon under the clouds 14 h 0 m Same as before 15 h 0 m Was still visible under the clouds

January 25th 10 h 0 m Auroral glow in the low north 10 h 30 m Only feebly seen 12 h 40 m It was active If any arch existed it was below the horizon There was not even a glow along the horizon, but the streamers and she[illegible] of light [illegible] nearly half way to the pole They w[illegible] not bright

January 26th 15 h 0 m Faint [illegible] low arch There was none ea[illegible] [illegible] 45 m Arch very low 3 deg [illegible] Bright changing patches in the arch

February 21st 9 h 30 m Very l[illegible] arch [illegible] part 3 deg high top of bright arch [illegible] 10 h 30 m There was an auroral [illegible] the dark part having sunk below [illegible] aurora had died down There were attempts at streamers for a while 16 h 30 m It was very bright again Arch almost on the horizon—so low that there was scarcely any dark beneath

March 19th There did not seem to be any aurora until 8 h 45 m when a long streamer appeared east of north which moved west At this time there was only the feeblest glow and no arch It became more active later and the glow was stronger 9 h 15 m Many streamers but no arch 9 h 45 m Great deal of glow and streamers some of which reached nearly to the pole 11 h 0 m The aurora was dead 12 h 30 m Nothing visible If there was any arch on this night it was below the horizon

March 20th 12 h 45 m Considerable auroral light and a few streamers (R) says 'all night

March 21st 7 h 50 m A feeble auroral glow

March 28th 11 h 30 m Splendid aurora curtains, ascending pulsations The curtain waves went east. At first the narrow streams went west 12 h 20 m It was not active at this time but the arch was very bright It extended very far east 12 h 25 m It was almost dead Same at 13 h 20 m This aurora was the finest example of curtain effect that I have seen here They were white and some of them bluish white These curtains moved rather rapidly east while the slender streamers that made their appearance previous to the curtains moved west all along the arch There were rapid ascending pulsations, and a broken second arch above the main arch 15 h 40 m Aurora active again. No definite arch but masses resembling bright cumulus clouds from which sheets of faint light were going up The aurora was more or less active until daylight It would frequently almost die out, then brighten up again. Its most active period was before midnight—about [illegible] h 30 m.

Observer absent from April 19th to April 30th Mr Lee reported that there was an aurora with low arch and some streamers at about 16 h on April 25th It was not bright.

October 18th A magnificent aurora was visible at 7 h I first saw it at 7 h 45 m At this time all the northern sky below the pole was covered with great masses of light, with apparently a double arch. It was very active at [illegible] m., with streamers and broken masses of light At [illegible] h 25 m there were great masses of light far in the northeast which drifted slowly to the west and rose higher until the sky to the zenith and as far as Saturn was covered with them At 8 h 30 m there were rapid ascending pulsations These ascending waves seemed to bring out and illuminate large areas of matter all over the north that were drifting westward At 8 h 35 m the arch had again formed and streamers (with dark intervals between them) all along its periphery A very fine sight Beautiful slender streamers ascended as high as Polaris Several of those to the left moved rapidly to the right or eastward These apparently passed others going west To the west the streamers were reddish but the general display was of a bright yellow Many of the slender streamers shot higher than Polaris At 8 h 45 m all the northern sky was covered with tufty masses of light which were elongated vertically At 9 h 5 m a thin bright arch extended to an altitude of 10 deg At 9 h 45 m there was a fine and bright arch at an altitude of 14 deg with bright masses far toward the east apparently separated from the rest of the aurora α Ursae Majoris was in the upper edge of the bright arch which was black beneath only toward the east the rest being luminous below the arch The arch was very perfect but not active At 9 h 58 m rapid waves were ascending all along the arch and pulsating diffusions of luminosity all over the heavens north of the zenith but the arch was not active no streamers At 10 h 1[illegible] m the arch became active to the west It had risen slowly and was then 17 deg high but it was not dark underneath Waves of faint light were ascending everywhere in the north to the zenith α Ursae Majoris was at this time in the lower part of the arch There were masses of light in the east free of the arch which was very large and wide extending along the horizon for 100 deg At 10 h 2[illegible] m there were beautiful curtains in the west springing from the arch and extending to great altitudes These moved rapidly to the east Their bases were bluish white with strong prismatic colors It was a splendid sight! Beginning at the west these curtain forming streamers would burst out along the summit of the arch which was very perfectly formed one at a time in rapid succession ascending to great altitudes Thus the arch was [illegible] to pieces The whole system of moving curtains [illegible] [illegible] light and fragments of streamers all over the north but no arch At 10 h 35 m rapidly ascending waves were rising everywhere in the north with great masses of light all over the northern sky extending to the east point 10 h 47 m Fantastic masses dancing all over the northern heavens to the zenith which seemed to be due to rapid pulsations of light which as they passed momentarily illuminated irregular masses of matter that were changing form slowly and moving to the west 10 h 2 m The rapid pulsations seemed to have ceased but there were still great masses of light all over the north to the zenith which would slowly brighten and fade At this time the arch was again forming At 10 h 55 m the arch was very black below and only half as high as before Ascending pulsations and bright masses all over the north to the zenith The sky was more or less luminous everywhere except in the far south The pulsations were still rising at 11 h 5 m and the arch was broken but at 11 h 35 m it was very strong again and very dark underneath Ten minutes later it was broken again by masses of light and some streamers At 13 h 0 m the arch was still pretty strong but not active At 16 h 20 m it was all dead except some pulsating masses of light near the northern horizon 17 h 0 m The same

This was one of the finest auroras I have seen here Especially was the display of curtains splendid at 10 h 22 m I have never before seen the brilliant prismatic color effects which burst out on the forming of the curtains I was strongly impressed with the resemblance of some of the streamers to comets tails etc They would shoot up sometimes very slender and then diffuse into broad wavy masses moving west The general motion was west except the curtains mentioned and the few streamers that moved east and the pulsations which were vertical At times great areas of feeble illumination would appear for a second or so all over the north Sometimes these illuminations were very bright They appeared like great areas of bright haze Altogether the display was one of the most brilliant I have ever seen

REMARKS ON THE RESULTS OF THE OBSERVATIONS

In reading the accounts given in Nature and the Astronomische Nachrichten of the luminous nights seen in England and on the Continent about the first of July 1908 by Denning and others I have thought that the phenomenon of the luminous night of May 26th, 1908 (and of other dates) was of a similar nature to those described by the various observers in July

In Nature for September 30th 1909 (81 395) Dr Chree gives an account of a great magnetic storm recorded at Kew which commenced suddenly at about 11 h 43 m A M on September [illegible]th The storm was of comparatively short duration no movements of any great size being recorded after 8 h 30 m P M on September 2[illegible]th and by 1 A M on September [illegible]th little trace of the disturbance was left

This same storm badly interfered with telegraphic operations all over the United States on September 25th According to the newspapers it was very active between 6 and 9 A M I observed all night on the [illegible]4th closing observations just before 1[illegible] h or [illegible] A M of the [illegible]th or 11 A M at Greenwich I looked out for any aurora just before daylight but there was none nor had there been any during the night which would be bright enough to be seen in moonlight As recorded above in my notes there was an aurora on the 2[illegible]th at 1[illegible] h 0 m I had suspected one earlier in the night but it was uncertain on account of the moon

For a valuable account of the condition of the solar activities about the period of this great disturbance see an article by Prof Frederick Slocum in the Astrophysical Journal for January 1910

For some years I have had in my mind a scheme for systematic observations of the aurora but for various reasons it has not been possible to carry it out as it would require the permanent residence of one observer some miles north of here The scheme would be to have someone say a resident of some place ten or twenty miles north of the Yerkes Observatory who would be familiar enough with the stars to locate an object with the naked eye by them or who had an instrument for the determination of the altitude and azimuth of such objects Suppose such an observer to be connected with the Yerkes Observatory by telephone Upon the appearance of any striking auroral phenomenon such as the moving fluctuating clouds simultaneous observations could be made of these that would give their true altitude above the earth As they sometimes remain visible for upward of an hour these observations would show if they varied their [illegible] ould also give accurately their real veloc[illegible] [illegible] and various other phenomena of [illegible] [illegible] such as I have described in the Astro[illegible] [illegible] ers at a distance really see the same thing [illegible] each person sees his own aurora as in the case of the rainbow as has been suggested by some writers. The fluctuating clouds and their motion would alone perhaps contradict this theory

In the present paper I have gone somewhat into detail in the accounts of the auroral displays here This has been done because it has appeared to me that in general the references to an aurora usually are wanting in details and leave doubt as to what kind of aurora had been present It would seem that there may be different kinds of auroras due to different causes or to modifications of some one cause If so these should be distinguished from each other For instance sometimes the fluctuating clouds have appeared when there was no other evidence of an aurora At other times they have been present during an ordinary aurora These clouds therefore would seem to depend on different conditions from the regular aurora At times these conditions alone are present at other times they combine with those necessary for the production of the ordinary aurora Certainly the conditions must have been different that produced the great band of May 26th 1908 So also must those that produced the luminous nights mentioned in these observations A classification of the various kinds of auroras would therefore be valuable It is with this idea in view that I have dealt more extensively with some of the displays of the past ten years

Table of Auroras Observed from 1897 to 1909 Inclusive

	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	No by Months
January		2	1									2	1	9
February			2						2	[illegible]	1		1	10
March	1	6							2	1	1		4	19
April	1			1		1		3			[illegible]	1	1	9
May		1	3	1		1				1	1	5	3	16
June			3					[illegible]		1		[illegible]	1	9
July	1		1										1	5
August	2	1	7				1			1	1		3	17
September		1	4	1			4		1		1		8	25
October	1	1					1	3		1	3			1
November		2	1		1		1	3	1		1	1		10
December	2	1					1				1	1		[illegible]
No by Years	8	16	16	3	1	2	11	10	6	9	27	40	21	1 0 total

The recorded times are important especially in case of the spasms of activity in the large auroras It would be interesting to compare these with the magnetic records to see if any special disturbances show at these times on the instrumental records

I will not here go into any discussion of the connection between solar disturbances (as indicated alone by great sun spots) and the aurora This does not lie within my province It may not be out of the way to state however that such a connection does not at present seem to be clearly established in all cases I have within the past ten years or so frequently noted solar spots so large as to be visible to the unaided eye These have not always been closely associated with auroral displays A most striking instance of this kind was shown in the case of a large naked eye sun spot on and about December 29th 1909 A careful record on every clear night about this time failed to show any evidence of aurora Indeed this prolonged absence of auroras (up to the latter part of January 1910) would have been noticeable without the incentive of the large sun spot to look for them

I have thought that it might be interesting to see if any months are more abundant in auroras here than others For this purpose Miss Calvert has prepared from my observations the foregoing table

This table gives the number of auroras seen in each month from 1897 to the end of 1909 The last vertical column gives the entire number for each month during this interval The horizontal column at the bottom of the table gives the frequency for the various years September has been especially prolific but September is a season of clear skies February also stands high but this high grade is dependent on the year 1907 July and December stand especially low There seems to have been a minimum of auroras from 1900 to 1902 The observer was absent on the eclipse expedition to Sumatra from the first of January to the last of July of 1901 The year 1908 gives the highest record of all—auroras on forty nights But the summer and fall of 1908 were remarkably free from clouds The combination of 1907 1908 and 1909 would seem however to indicate a maximum in which we are now placed or which we have just passed through

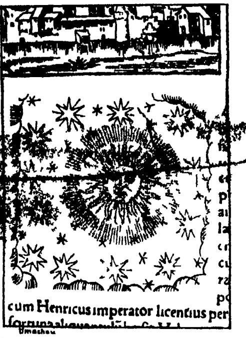
It is evident however that to determine accurately the frequency of auroras here in the past thirteen years it would be necessary to compare the observations with the various meteorological conditions that have prevailed in that time I have not the leisure at present to undertake this work and so the results must stand as they are

COMETS' TAILS AND THE EARTH.

THE EARTH'S PASSAGE THROUGH THE TAIL OF A COMET 804 YEARS AGO.

BY WILHELM KREBS.

On May 18th at 9 P M Eastern Standard Time Halley's comet will pass directly between the sun and the earth and its tail will sweep over and envelop the earth This remarkable conjunction which may cause great perturbation in the orbit of the comet and may also furnish data from which the comet's mass can be determined will be visible only from that part of the earth that is then turned toward the sun i e the Pacific region and any effect produced on the earth by its passage through the comet's tail will be most conspicuous in the same region The American Astronomical Society and the American Academy of Science have sent a joint expedition to the Hawaiian Islands for the purpose of observing the conjunction and of photographing the comet when it is at and near its perihelion and its tail is most strongly developed


cum Henricus imperator licentius per

Umschau

THE METEORIC SHOWER SEEN BY DAYLIGHT AFTER THE PASSAGE OF THE COMET

Umschau

THE PASSAGE OF THE GREAT COMET OF 1106 BETWEEN THE EARTH AND THE SUN

From the Book of Wonders published in Germany in the 16th century

There is no reason to fear that we shall all be killed by the poisonous gases of the comet's tail although Camille Flammarion has endeavored to revive this spectre which arose in 1832 when a collision between a comet and the earth was predicted

The only certainly proved passage of the earth through a comet's tail occurred on June 26th 1819* No effects due to the passage were detected but the comet was a small one although it showed a tail of considerable length when it emerged from the sun's radiance on the last night of June the only night on which it was generally visible to the naked eye It was predicted that the earth would pass through the tail of a very large comet in the latter part of June 1861 but the calculations were afterward shown to be erroneous

In this connection it is interesting to note that a miracle book of the 16th century mentions the passage of a very large comet between the earth and the sun and a phenomenon apparently connected therewith The events are alleged to have occurred in 1106 The book which appeared in 1557 under the title Prodigiorum et Ostentorum Chronicon was written by Conradus Lycosthenes The most probable translation of the rather obscure Latin passage runs about as follows

On the 5th of February a comet was seen in the sky in the daytime from the third to the ninth hour about an ell distant from the sun Soon afterward on the same day at Bari in Italy stars were seen by daylight, now appearing to race with each other across the sky now seeming to fall toward the earth

In short we are told that on February 5th 1106 a comet was seen near the sun in broad daylight and that the still rarer phenomenon of a daytime meteoric shower was observed soon afterward

This great comet of February 1106 was one of the most striking apparitions in the history of astronomy It was seen not only in Europe but also in Palestine and China Later in the month according to Maedler its head was in the constellation Pisces while its tail stretched out toward Orion and covered a large part of the sky The head was not very bright Upon this comet Whiston founded his system of cosmogony

Newton in 1680 predicted the return of this great comet about the year 2255 This was the first computation of the orbit of a periodic comet and it served Halley as a model when two years later and at Newton's suggestion he calculated the orbit and periodic time of the comet which has since borne his name But while Halley's calculations were confirmed by the observed return of his comet only 17 years after his death those of Newton cannot in the most favorable event be confirmed until the year 2255 The accuracy of Newton's result has furthermore been made very questionable by Encke's recalculation

The fact of most importance for our purpose that has been recorded concerning the great comet of 1106 is that it remained not only visible but brilliant for more than two weeks after its passage between the earth and the sun on February 5th and did not begin to wane and dwindle until February 20th

Hence the effect produced even on the light and tenuous comet by the conjunction was not serious and the influence exerted on the massive globe of the earth protected by its atmospheric mantle must have been very much smaller The only apparent consequence was the fall of an unusually brilliant meteoric shower —Translated for the Scientific American Supplement from Umschau

ABOUT MOUNT ETNA

The reports as to the numerous craters which says English Mechanic and World of Science are active at Etna are what might be expected for one of the peculiarities of Etna is the extraordinary number of minor cones—[illegible] at 200—which are scattered over its [illegible] The main crater according to Mr G [illegible] who [illegible] an ascent in 1877 is a very [illegible] in depth shut in by precipitous [illegible] its [illegible] vary but it was [illegible] les in circumference [illegible] a, at other times it [illegible]

[illegible] the most [illegible] was that of 1669 an account [illegible] was written by the Earl of Winchilsea, onetime British Ambassador at Constantinople, who was an eye witness of the phenomenon He says the eruption took the form of an inundation of fire a flood of fire cinders and burning stones burning with that rage as to advance into the sea 600 yards and that to a mile in breadth and that which did augment my admiration was to see in the sea this matter like rugged rocks burning in four fathom water In forty days Lord Winchilsea went on to say the eruption destroyed the habitations of 27 000 persons made two hills one 1 000 paces high and the other four miles in compass while of 20 000 persons inhabiting Catania only 3 000 remained

According to Baron von Waltershausen who has supplied the most exhaustive description of Mount Etna no fewer than 300 000 people live on its sides. Thus with an area rather larger than that of Bedfordshire (462 square miles) it has more than double the population

The surface of the mountain consists roughly of three different regions—namely the cultivated region at the base yielding all the ordinary products of Sicily such as vines corn olives pistachio nuts mulberries oranges lemons figs and other fruit trees Above from the height of 2 000 feet to an approximate height of 6 300 feet extends the woody region comprising fourteen separate forests some abounding with oak beech pine and poplar, others with chestnut ilex and cork tree

The desert region lies between the limit of 6 300 feet and the summit (about 10 867 feet) It occupies an area of about ten square miles and consists of a dreary waste of black sand scoriæ ashes and masses of ejected lava In autumn winter and spring it remains permanently covered with snow and even in the height of summer snow may be found in rifts near the summit

Sharpening the bits of the 300 rock drills used in the Calumet and Hecla mines is done automatically the only labor being to put them on a conveyor at the outset They are heated sharpened upset fluted brought back to exact size and tempered by machines passing from one to the other mechanically The plant is driven electrically but the sharpening and upsetting are performed by compressed air hammers, and the fluting is done by an 800-pound steam hammer With all drills running about 1,000 bits must be sharpened every day.

CHARLES DICKENS AND DONATI'S COMET.

"CHIPS FROM THE COMET."

When Charles Dickens was the Editor of Household Words there appeared in its pages for the issue of November 1858 an article on Donati's Great Comet of 1858 entitled Chips from the Comet. Whether or not this article was written by Dickens it is difficult to state but there is internal evidence of touches of his. The article follows.

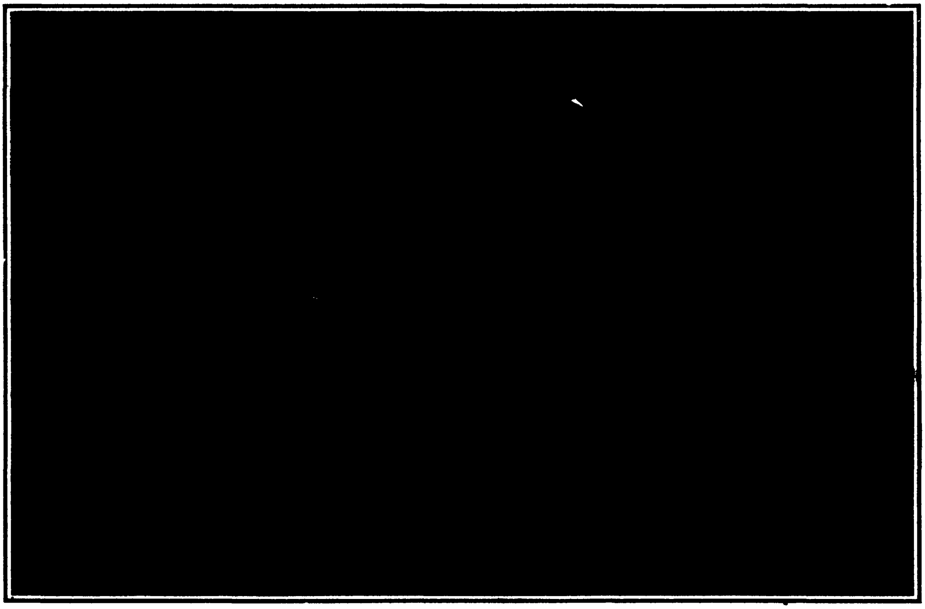
From first to last Donati's comet has thrown off more chips than people in general dream of some of them very considerable ones. It has turned out to be a sort of celestial egg inclosed in a multitude of shells which it got rid of as it approached the sun like the traveler who cast aside his cloak under the mild persuasion of Phoebus Apollo although Boreas had in vain endeavored to force it from him. Donati's comet exhibited one very remarkable phenomenon. It formed successively around its central nebulosity a series of luminous envelopes distant and distinct from each other till they attained the number of eight at least, so that the comet seemed to be a never-ending nest of boxes of light.

Similar *phenomena* were observed by the first Herschel and by Olbers in the grand comet of eighteen hundred and eleven. What physical condition of the star itself can be conjoined with such a continual casting of luminous skins it is difficult for us to imagine in our wildest reveries. It would seem at least to betoken the impossibility that the hairy wanderer (*cometa* derived from *κόμη* *coma*, a head or hair) should be the dwelling place of any animated beings whatever. And yet, if we had never seen fish nor water insects and mollusks and had no further experience of water than that it drowned us whenever we fell into it and remained submerged we might be tempted to say, that it was impossible for organized creatures to exist in water. Therefore, we must hesitate before deciding that even Donati's comet may not have its inhabitants whom we may suppose to wake up and dance like a swarm of gnats at their approach to the sun and to fall again into torpid lethargy when their long long winter recommences.

That the existence of such cometarians is improbable though not impossible may be concluded from the observations and reasonings of Monsieur Brento. That learned astronomer remarked that the brightness of Donati's comet was less than that of the atmosphere soon after sunset which is less than that of the same atmosphere during daytime which is less than that of the moon when she is visible in broad day which is nearly equal to that of a little white cloud of the same angular diameter. Yet the comet was fully exposed to the blazing sunshine and was illuminated by its rays about three times as much as we are. If we combine these indications with the immense depth of the comet which our visual rays traversed—an ocean of luminous matter millions of miles deep in the portion of the tail comparatively near to the nucleus—some idea may be conceived of the excessive rarity of the vapor or dust of which the heavenly body is formed.

The curiosity of the public was greatly excited to trace the development of the tail but that development may be easily understood as soon as the excessive rarity of the comet's ponderable matter is taken into account. Whether dust or vapor it is believed to be in any case an incoherent assemblage of atoms and moreover that every ponderable atom of the tail follows its own proper orbit independently of the orbits of the neighboring atoms. Now if you throw into the air a shovelful of sand it requires particular care and especial address to make the sand fly all in one mass like a stone, it is a necessary condition of such a feat that the grains of sand when they leave the shovel should all have equal and parallel velocities. If this condition be not fulfilled every grain follows its own course separately. These courses diverge and separate and the shovelful of sand spreads itself out into divers forms. It is like the contents of a gun barrel laden with small shot. The charge rarely forms a ball or flies in one compact mass every single shot follows its own independent trajectory and the charge spreads.

Besides this the observations and calculations made on the course of the comet's nucleus indicate that it the nucleus has an elliptical orbit with a period of about twenty-one centuries. But all the particles which may have acquired even moderate accelerations would necessarily assume hyperbolical orbits. An ellipse or oval is a curved line which returns into itself like a circle and might equally like it be taken for an emblem of eternity. A hyperbola is a sort of oval with one end burst open and the lines imperfectly straightened so that there is no return into itself. It has a curve which may be roughly compared to a pair of sugar tongs with never-ending legs distended by a large lump of sugar for hyperbolous legs may be lengthened or may extend infinitely. Consequently if any cause breaks open a comet's elliptical orbit or the elliptical orbit of any of its non-coherent portions so as to pull and wring it into a hyperbola there is no more return possible for that comet or that portion of a comet. Now when we remember the immense length of a comet it is clear that the perturbations of the planets acting unequally on the different portions of a comet in consequence of their unequal distances are certainly sufficient to give them diverging orbits. The materials of the tail are thus dissipated forever or nearly so. Therefore could



By Courtesy of the Sphere

This picture shows the greatest comet of the nineteenth century as it appeared to an English observer who was an exhibitor at the Royal Academy. At the time when the painting was made the tail was sweeping over the bright star Arcturus which shone undiminished through the nebulous plume the extremity of which reached the stars forming the handle of the Dipper (Ursa Major). To the left were the stars of Libra and to the right the stars of Leo. The comet was discovered by Donati at Florence on June 2nd 1858 as a small telescopic object approaching the sun. Not for nearly three months did it become visible to the naked eye but then right up to the time of its perihelion passage at the end of September it grew rapidly in brightness until its starlike nucleus was as bright as the Pole Star. During September its tail was directed nearly towards the earth and though bright was seen so much foreshortened that its effect was greatly marred but as the comet passed perihelion and began to recede from the sun its path by good fortune was most favorably placed. The splendid bright tail then lay almost at right angles to the line of sight and its whole length was for the first time displayed. Other comets have had longer tails though this was more than 40,000,000 miles long but none have surpassed Donati's comet in beauty. The main tail the curved plume was of the type shown afterwards by the spectroscope to consist of hydrocarbons the thin straight streamers are of the hydrogen type. Evaporated apparently from the nucleus of the comet by the heat of the sun the particles of the tail are repelled from the sun by some force whose nature is still problematical and driven backwards from it with enormous speed.

DONATI'S GREAT COMET OF 1858.

we even live one and twenty centuries like Donati's comet we never shall look upon its like again even if we saw its professed self Finally Donati's comet appears to have experienced at its perihelion powerful physical actions from the solar heat These actions must have accelerated the particles of one half of the nucleus and retarded those of the other half so that the former would take orbits of long period or even hyperbolical orbits whilst the period of the latter would be shortened Donati (who is about to publish drawings of his comet in its different phases) himself says that there can be no doubt that the sun successively detached matter from the comet's head which matter was afterwards dispersed by taking its departure from the nucleus to constitute the hairy portion of the tail of the star A comet would thus be a magnificent firework which would burn itself out and become dissipated by the very act of its display

From the motion of comets which describe hyperbolical orbits Monsieur Brento ingeniously calculates the direction and the greatness of the sun's motion of translation through space It would appear that at the present moment the sun's velocity of translation instead of being great and proportional to the magnitude and importance of that heavenly body is scarcely equal to the sixth of that of the earth in her orbit

Prof Govi one of Donati's friends ascertained in the first place the polarization of the comet's light confirming what Arago had observed in eighteen hundred and thirty five in Halley's comet secondly he determined the position of the plane of polarization of this light whose plane coincided sensibly with the axis of the tail This coincidence continued to exist till the tenth of October after which date bad weather prevented the comet's being observed for some time This position of the plane of polarization in reference to the position of the sun removes all doubt as to the source of at least the most considerable portion of the light with which the comet shone namely that it was derived from the sun

These are not the only nor the least considerable chips that have fallen from the comet and its predecessors Our readers will recollect that the existence of the ether (if demonstrated) was demonstrated by a comet It had been previously rendered probable and has since been confirmed by calculations based on the undulatory theory of light as a hypothesis and by their accordance with the actual phenomena The discovery of the phenomena of interference in which two lights by mingling with each other reciprocally annul each other's effects that of the polarization of light which renders its rays susceptible of being reflected without being refracted in a certain plane for that particular ray and susceptible on the other hand of refraction and not of reflection in another plane holding a special relation to the first These two grand discoveries of modern natural philosophy have compelled mathematicians to recognize in light a series of undulations which are propagated in an eminently elastic fluid named by them as we know the ether And then the retardation which the propagation of light suffers by passing through bodies endowed with the highest refracting powers (well established by divers experiments) gives strong support to this view of the nature of light But further from the notion of a repulsive ether Monsieur Brento has deduced a sublime consequence and has thus made a comet the parent or rather the ancestor of a new proof of the infinity of the created universe

In the first place since the light and heat of the stars can only reach us by the agency of the ether it follows that this fluid must fill the whole of the celestial space in which the stars perform their movements Secondly as everything indicates that the movements of the stars in the firmament do not meet with any sensible resistance it follows that the density of the ether which they traverse must be indefinitely small in comparison with that of the stars lastly since the light of the stars evidently reaches us in straight lines it follows that the density of the ether must be sensibly uniform But if the molecules of the ether attracted each other their dispersion throughout space could not continue uniform It is true that the exactly uniform dispersion of an attractive fluid would constitute a state of equilibrium but it would be an unstable equilibrium That is to say if disturbed by the slightest local condensation or refraction the equilibrium would be broken the fluid would instantly rush in masses to various centers in virtue of its attractive power and the uniform dispersion of the fluid would no longer exist There would ensue immediately in some places partial and local vacuums and in others local and limited condensations of the fluid

On the other hand a fluid whose particles repelled each other if distributed in a nearly uniform manner in unlimited space would tend more and more to a uniform distribution of its particles Any partial local vacuum would be instantly filled up by the adjoining particles rushing in In like manner any partial and local condensation would determine a repulsion by which the too crowded molecules would be driven away from each other till they met with an equal repulsion from without Thus the uniform density of the celestial ether which remains sensibly the same in spite of the local movements of the heavenly bodies shows that the atoms of the ether repel each other And that the energy of the living forces transmitted by the undulations of the ether—the power of the solar light heat and chemical action—proves that the repulsion of its constituent atoms is enormous

Bearing these facts in mind is it possible to conceive that the ether occupies a finite space in a firmament geometrically infinite in every direction?

If the extent of the ether is limited it is absolutely necessary that the space it occupies should be enclosed in some vast continuous distended envelope capable of offering sufficient resistence to the ether's expansive force in spite of the enormous radius and span which this sort of roof or vault must have If therefore the ether be limited we come back to the ancient dream of a solid transparent firmament made of crystal or of whatever other substance you please Be it remembered that this firmament must inclose not only the sun and its planets but every star which we behold and the Milky Way of which they form part and the nebulæ amongst which our Milky Way is only a single individual and the congregations of nebulæ and the congregations of those congregations and so on to infinity there being nothing to authorize our limiting the number of the degrees of this stellar hierarchy Such an idea as that of a crystal wall bounding the universe can hardly stand a moment's reflection

We are consequently led to conclude that the celestial ether has no limits whatever, but that it actually extends infinitely in every direction of the geometrical heavens It now remains to inquire whether in this etherized immensity the congregations of stars can by possibility be assembled within a limited space beyond which there exists nothing but the ether only in all directions to infinity

The totality of the stars which exist in the celestial ether continually transmit to it an enormous quantity of vital force This force travels through the ether in calorific and luminous undulations and goes further and further away indefinitely from the centers of vibration with nothing to stop it, unless the undulations meet on their way with atoms of a nature heterogeneous to the ether which retain after the passage of a wave some fraction of the vital force of that wave Consequently if all the ponderable matter of the universe is confined within a given space all the light and all the heat which makes its escape from this inclosure would be definitely lost to the stellar universe which would therefore cool and grow dark to an indefinite extent and after a lapse of time which though very great is still finite an epoch would arrive when the sum of subsistent vital force would fall below any appreciable limit But if on the contrary the ponderable universe is infinite like the celestial ether in all directions the whole of the vital force propagated in the heavens remains always within the circumference of this ponderable universe In that case the conservation of action and of vital force becomes separately applicable on the one hand to the totality of the celestial ether and on the other hand to the totality of ponderable matter What is given and taken is returned from their opposite quarter in equal measure upon the whole there is no absolute loss or escape of vital force

Thus a finite universe swimming in an infinite ether must little by little lose its living energies without the possibility of regaining them an infinite universe on the contrary must preserve its total vital force under any changes whatever in its distribution such changes being produced partly through the medium of the repulsive ether and partly by the action of the universal gravitation The latter of these two hypotheses appears the only one admissable In fact all the manifestations of the creative power which are one in kind appear *a priori* to be necessarily inalterable in their sum provided we conclude in that sum the absolute totality of creation This law and that of continuity are perhaps the two laws which are the most general throughout all creation and the notion of the indestructibility of matter now admitted as an axiom rests upon no other foundation

An endeavor has therefore been made to establish the proposition First that the celestial ether (inferred from the retardation of Encke's comet) extends infinitely in all directions in a firmament geometrically infinite Secondly that the ponderable universe is distributed through all the ethereal space without its being possible that any finite boundary how vast soever we may conceive it to be can contain the whole of this ponderable universe

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QUARTZ PRODUCTS

The mineral known as quartz (anhydrous silica SiO_2) found its first technical application a few years ago in the manufacture of tubes for mercury vapor lamps by the process of Dr Küch and the Heraeus Company This fused quartz or quartz glass was obtained from rock crystal and its cost was consequently very high The valuable properties of fused quartz which is not affected by great variations of temperature or by acids and is a remarkably good insulator make it very desirable to obtain this material at a moderate cost and in large quantities Heraeus succeeding in reducing the cost of production of fused rock crystal to some extent and in placing on the market laboratory vessels of quartz but the price remained very high until quite recently when it was found that the expensive rock crystal could be replaced by the very pure quartz sand which is known as glassmaker's sand Quartz products are already being made in large quantities by the German Quartz Company The material is used in the production of dishes flasks muffles tubes beakers test tubes crucibles funnels mortars and other implements and vessels used in chemical laboratories Even cooking vessels wall plaques and ornamental vases are made of fused quartz and the new material will unquestionably soon find a still wider field of industrial application

According to the German Quartz Company the sand employed in the manufacture is almost absolutely pure silica and the quality of the product is greatly injured although its appearance may possibly be improved by the addition of any other substance In addition to its resistance to acids (with the exception of fluoric and phosphoric acids) its insentiveness to great and abrupt changes of temperature and its very high electrical resistance fused quartz possesses the power of withstanding very high temperatures so that vessels of this material can be employed for the fusion of metals of very high melting points Some of the quartz offered by this firm is translucent and has the sheen of mother-of-pearl on its unpolished surface It can be cut polished and worked in the blowpipe flame Its specific gravity is 2.2; its specific heat 0.305 its fusing point about 2 000 deg C (3 632 deg F) Its expansion by heat is only 0.0005 for 1 000 deg C or about one tenth that of glass An electromotive force of 35 000 volts is required to force an alternating current of 50 cycles per second through a plate of material ¾ inch thick and 70 000 volts are required when the thickness is increased to 3 inches —Prometheus

* * *

THERMAL RADIATIONS OF GREAT WAVE LENGTH

It is well known that the visible spectrum comprises only a small part of the entire spectrum known to the physicist The wave lengths of the luminous rays lie between 0.4 and 0.8 μ (1 μ = 1/1 000 millimeter or about 1/25 000 inch) The ultra violet region of the spectrum which has been explored chiefly by photographic methods extends from 0.4 μ to 0.1 μ In the ultra red region the rays of which are detected chiefly by their thermal effects, the extreme lower limit attained until recently was represented by the residual rays reflected by sylvin which have a wave length of about 61 μ These rays were obtained by Rubens and Aschkinass by reflecting the radiation of a suitable source repeatedly by means of mirrors of sylvin In the process the greater part of the radiation is absorbed The remainder the so-called residual radiation is very homogeneous and has the wave length given above Rubens has recently continued his investigations and has succeeded in obtaining rays of much greater wave length up to 96.7 μ or nearly 1/10 millimeter by means of reflection from potassium iodide From this point to the extreme ultra violet the spectrum contains about ten octaves of which two are in the ultra violet region one in the visible section and seven in the ultra red The shortest ether waves obtained by electrical methods have a length of 4.4 millimeters and are therefore several octaves below the rays last mentioned The known varieties of electro-magnetic waves are given in the following table

	Wave length
Waves employed in wireless telegraphy . .	A few meters to several kilometers
Residual rays from potassium iodide .	0.0967 millimeter or 96.7 μ
Residual rays from sylvin	62.0 μ or 70.3 μ
Beginning of the visible spectrum	0.8 μ or 800 μμ
Red . .	. 760 μμ
Green	550 μμ
End of the visible spectrum	400 μμ
Ultra violet rays . .	400 μμ to 200 μμ
Schumann rays obtained in vacuo	200 μμ to 100 μμ

(1 μμ = 1/1000 μ or a millionth of a millimeter.)

VISIBLE MOLECULES, CORPUSCLES, AND IONS?

THE NEW THEORY OF MATTER.

WHEN a hundred years ago John Dalton gave its modern shape to the atomic theory which may be traced back to ancient philosophy and to Democritos, nobody expected that scientists would some day isolate or at least render visible the single atom and molecule. The kinetic theory of gases ascribed the gas pressure to the bombardment of the walls of the confining envelope by the gas molecules. It taught us how to count and to measure the molecules. But it did not bring the probability of our ever seeing them any nearer, that looked hopeless with 3×10^{19} molecules in a cubic centimeter of a gas and 640 trillion of atoms in a milligramme of hydrogen. Now that the very foundations of the atomic theory appear to be shaken by the discovery of particles (electrons) one seventeen hundredth of the size of the atom of hydrogen and by the phenomena of radioactivity it is claimed that the visibility of the smallest particles has been demonstrated in various ways. It may be opportune to examine some of the experiments on which such claims are based.

The existence of particles smaller than the atom would not in reality contradict the atomic theory. The atomic theory does not assert that the atom is the smallest particle capable of existence. The name 'atom' indeed suggests something that cannot further be cut or divided. But the essence of the theory is that an elementary substance consists of particles or atoms all equal to one another and peculiar to that element and that the single atom is the smallest particle which can enter into combination. The molecule is the combination product of atoms. The atom need not necessarily be the smallest ultimate particle and many considerations induce modern science to believe that the atom may itself have a constitution. The atoms of different elements differ from one another. Yet the modern scientist feels with the ancient philosopher that there may after all be only one kind of matter which being grouped in different ways gives rise to different elements and bodies. There are certainly difficulties in the suggestion that atoms or molecules should be able to split off corpuscles and remain substantially what they were, while on the other hand radium—probably an elementary metal—is to emit radiations which turn into helium—undoubtedly a gas. But those researches are not completed yet and meanwhile chemists continue to adhere to the atomic theory which has proved so fruitful and to determine atomic weights with the greatest possible care.

The demonstrations of the possible visibility of molecules are based on observations partly made in less controversial fields. Colloids have furnished the first suggestion of visible molecules or groups of molecules. When mud is stirred up the particles settle quickly again and the turbid liquid can by filtering be cleared of suspended particles. The particles of an oil emulsion take a long time to settle and run turbid through the filter. When still finer particles are prepared for instance by volatilizing metal electrodes immersed in liquids the cloudy particles will not settle for many days or months and finally it may be impossible to decide whether an emulsion or a real solution has resulted. It is quite conceivable that the transition from a suspension to a solution is too gradual to permit of a distinct line of demarkation being drawn just as the three states of aggregation cannot rigorously be distinguished. Very small suspended particles now are in constant oscillatory movement. These movements were first observed by the botanist Brown in 1827 and are known as Brownian movements. The coarser the particles, the slower and more irregular the movements. For a long time they were ascribed to inequalities of temperature in the turbid liquid. When the ultra microscope was brought out in Jena the study of this curiosity assumed a direct scientific interest and the impression gained ground that the observer really watched molecular movements akin to those which the particles of gases describe according to the kinetic theory of gases. The idea originated we believe, with Einstein, he certainly worked out the mathematics of the problem. During the past few years J. Perrin, Gouy, Svedberg and others have supplied apparent experimental proofs for the molecular character of the movements. Perrin counted the number of gamboge granules or particles, in a portion of his colloidal solution, measured their diameters, masses, and paths, and calculated their average kinetic energy. He concluded that the granules had the same average energy of movement as the molecules of the liquid in which they were suspended, and that they behaved thus like molecules of a very high molecular weight.

Now molecules of a high molecular weight—in other words molecules consisting of a great number of atoms of different elements are nothing strange to the chemist. Emil Fischer in his famous researches on the albuminoids has come to very high molecular weights indeed. In his four series of experiments Perrin dealt with granules whose masses varied as 1 : 8 : 27. Allowing for the coarseness of his granules and the friction in his medium (water) Perrin deduced for the number N of molecules per cubic centimeter very nearly the same figure 3×10^{19} to which other researches have led us. Estimates of this N we should add have been made by the most varied and entirely independent methods. Some of the methods give results which it may be foreseen should be considered as upper limits others will yield lower limits. The average accepted value for N was a few years ago probably 6×10^{19} at present scientists incline to half that value 3×10^{19}.

The experiments of Ehrenhaft confirm those of Perrin. Ehrenhaft volatilized silver electrodes in air the fine dust granules thus produced exhibited the looked for Brownian movements and the free path was longer in air than it had been for granules of the same size in water. Perrin's calculations have on the other hand been questioned by Duclaux. But we appear to be justified in assuming that the observer watching the movements of colloidal particles sees movements similar to those which we ascribe to the invisible molecules of gases.

Another demonstration of luminous effects ascribed to single particles was given by Crookes in London and Regener in Berlin seven or eight years ago and thus before the above mentioned experiments on colloids in which molecules are supposed to be concerned. When the α rays of radium are allowed to fall on a screen or fluorescent zinc sulphide each particle seems to produce a flash of light like a tiny spark and brilliant scintillations are observed. Still more instructive is the demonstration of single α particles which Rutherford and Geiger gave in the Royal Institution two years ago. It was described in our columns at the time. A tube containing radium bromide was held in front of the window of a long tube several feet away from the window so that only a few α particles—perhaps not more than one per second—would find their way to the electrometer at the far end of the tube. A sudden jerk of the electrometer indicated that a particle had struck and the number of particles shot out per second were actually counted by counting the jerks. Each α particle is supposed to represent a charged atom of helium which turns into helium gas on losing its electric charge. Dewar has carefully determined how much helium is produced by a given weight of radium per second and by putting that figure together with his count of the number of α particles discharged per second Rutherford arrived at the conclusion that 1 cubic centimeter of helium is formed by 2.56×10^{19} α particles—a most remarkable confirmation of the N.

Another exemplification of the visibility of molecules or at any rate of the discontinuity of an apparently homogenous solution is due to the late Lobry de Bruyn and has recently been verified by A. Coehn. It refers to the so called Tyndall effect. A ray of light is as such invisible in an optically empty medium. Passed through a glass trough the beam of the lantern is hardly visible until some turbid medium like smoke is introduced into the trough. The light cone of a lens concentrated into pure water leaves the water dark when it is free of suspended particles dust etc. It is of course exceedingly difficult to free the water of all dust and floating impurities. Working with the greatest care Lobry de Bruyn succeeded in obtaining pure water in which the light cone was hardly discernible. But when he dissolved cane sugar in this water a luminosity was noticed. Coehn has repeated this experiment with the ultra microscope of Zsigmondy and the light cone then observed was quite uniform. Dust particles or colloids would have shown as bright points. It would therefore appear that the large molecules of cane sugar dispersed through the water make the water sufficiently discontinuous to reflect the light.

The further endeavors of Coehn to exemplify this discontinuity in solutions in which a transport of the ions and of non-electrolytic particles drifting with the ions, is produced by electrolysis, will be better understood by a description of some very remarkable experiments of Kossonogow of Kiew. Kossonogow studies electrolysis with the aid of the ultra microscope. He bends both the electrodes of his cells twice at right angles, so as to leave a channel, generally 0.2 millimeter in width, between the active surfaces and coats the other portions of the electrodes with paraffin. The light beam is sent across this channel in which electrolysis takes place. On dissolving various salts, silver nitrate, copper sulphate, ammonium chloride and others in water he observed at once before turning on the current some luminosity and bright specks in Brownian movements. Some of the specks were no doubt dust particles. But the just mentioned discontinuity phenomena and further migration of the ions were also found. For the luminosity increased when the current (of 10 volts e. g.) was turned on and the particles were distinctly seen to wander mostly toward the cathode. If dust granules had alone been at work the current should gradually have cleared the solution of such granules. But the directed movements were only observed when there was real electrolysis and no movements and hardly any luminosity were seen when the solvent was not water but a nonelectrolyte like benzol. The bright specks were moreover deflected from their rectilinear paths when the cell was placed in a strong magnetic field. On reversing the current the bright specks also reversed their movements which took place at the rates of migrating ions and on applying alternating currents the particles seemed to be undecided which way to move.

All these observations appear to indicate that the moving particles are either ions or other bodies or molecules drifting together with the ions and it has long ago been pointed out that the migrating ion would carry some of the solvent with it. The following observations of Kossonogow are of particular interest. When a certain critical potential was applied the number of bright specks suddenly increased very much and they crowded near the cathode but a dark space from 0.0 to 0.08 millimeter in width was always left close to the cathode. This dark cathode space so well known from experiments on the electric discharge through gases was very well defined and it was particularly striking when cathodes were used which were not plain but curved in fanciful ways. The boundary of the dark space always kept parallel to the contours of the cathode. Beyond the dark space the bright particles were in lively motion but no bright particles crossed the dark space though the ions must traverse it to be deposited on the cathode. It looked Kossonogow says as if the ions lost their luminosity together with their electric charge when passing the dark space. When the critical potential 1 volt for silver nitrate in water was exceeded another crowding of the bright spots to a bright band was noticed intermediate between the electrodes. The crowding of the bright points and the dark space were also seen in copper sulphate. When silver electrodes were dipped into a colloidal solution of silver in water the phenomenon changed. The bright spots crowded near the anode not near the cathode but there was no dark space separating them from the anode.

Whatever one may think of the interpretation of these phenomena it will be conceded that the decomposition products of electrolysis are concerned in them. Whether the bright spots seen are really the ions whether the optical discontinuity is really due to single molecules whether the scintillations and electrometer discharges are indeed produced by single α rays i. e. single charged helium atoms—and whether the colloidal granules represent real analogues of molecules whether in brief the phenomena which we have reviewed really constitute effects of ultimate particles these questions remain open of course. Chemists decline to follow physicists into some of their novel theories. But problems present themselves which were unknown to the exact science of past generations though such questions entered into their speculations and the perfection especially of electrical and optical methods and instruments of research certainly has provided us with means of conducting investigations which the past generations could hardly hope to attain.—Engineering.

The Aero Club Committee of France have submitted the first proposed rules of the air to the French Minister of Public Works. Airships and aeroplanes are to fly at not less than 150 feet clear of buildings and inclosed property and they must not stop above such property at any height less than 1,500 feet. Aerial craft must pass to the right and dirigibles are to have the right of way over aeroplanes. Special permission must be obtained to fly over towns and cities. Aviators must be examined and licensed and license numbers must be displayed upon the machines. All buildings over 150 feet in height must be lighted at night time and the names of villages must be painted in large letters on the roofs of railway stations.

ELECTRICAL NOTES

Quite recently the large wireless station at Nauen near Berlin has maintained communication with a steamer of the Woermann Line during the whole of its journey from Hamburg to West Africa and to continue to exchange messages with it after it had come to anchor at the Cameroons From there to Nauen the wireless distance is roughly 4 000 miles and the waves had to negotiate such obstacles as the Alps the Algerian tableland and the mountains of Adamana This is by far the best overseas and land record yet made

The Electrical World gives particulars of the experimental trials now being carried out by the United States Navy Department with a view to insuring wireless communication over great distances It is intended to erect a master station at Washington with an iron mast [illegible] feet high and transmitting apparatus of 50 kilowatt capacity Other naval stations will be equipped with [illegible] kilowatt apparatus and battleships and first class cruisers will have 10 kilowatt installations all of high frequency and capable of communicating over a distance of 1 000 miles not only by night but also by day a much more difficult feat The makers of the Fessenden apparatus have secured the contract and are carrying out trials to meet the specified conditions with the aid of naval vessels equipped with the Fessenden system

The advocates of the continuous current system as against the single phase system for electric railways have just had their claims supported in a forcible manner The Washington Baltimore and Annapolis Railway was changed over from single phase to 1[illegible]00 volt continuous current on February 1[illegible]th The reason for the change was that the company desired to run into Washington city but was prevented owing to the weight of its cars An investigation followed which promised large savings in first cost and operating expenses The change was therefore decided on and the results are said to have fully substantiated the findings of the commission It is stated that the saving in electric energy amounted to [illegible] per cent even during the first few days when the drivers were new to the equipments

The Virginia Railway and Power Company Richmond Va formerly used for its armature and axle bearings a tin base metal which proved unsatisfactory as the bearings broke frequently before the metal was worn away to any considerable extent The old metal ran from 12 000 miles to 26 000 miles in the armature bearings and 11 000 miles to 13 000 miles in the axle bearings It has now been replaced by a bronze bearing composed of 77 per cent copper 15 per cent lead and 8 per cent tin Some of these new bearings have already given over 50 000 miles and are still in service All armature bearings are bored with a self centering machine and afterward rolled under pressure which gives a remarkably smooth finish and thereby tends to increase the life of the bearing since at the start there are no inequalities in the surface

Various methods have been employed for the purpose of protecting electric light and power wires from accidental currents of high potential and high frequency The oldest method consists in inserting between the line and the earth in parallel with the self induction coil a condenser of small capacity which allows the accidental current of high frequency to pass without involving appreciable loss of the working current Effective protection is given also by the Giles valve which is composed of a fusible plug a spark gap a resistance and a lightning arrester with numerous gaps formed of disks of zinc insulated from each other The high frequency current escapes to earth through all of these instruments, which are connected in series but the escape of the working current is prevented by the spark gap A third device consists of a series of electrolytic valves which serve both to increase the capacity and to limit the tension They are usually connected in series with lighting arresters of the horn type

ENGINEERING NOTES

We hear that the Swiss State Railway authorities are engaged in securing water power all over the country for the purpose of electric power supply for the railways The power secured in Canton Tessin now amounts to 30 000 horse power and in Canton Uri to 1[illegible]000 horse power The total amount already taken is about 70 000 horse power and still more is required

The Krupp Works at Essen in Germany are constantly increasing in size The number of men employed by the company at its work in Essen and elsewhere increased during 1909 by nearly 4 000 so that at the end of of 1909 about 67 000 men were in the employ of the company At the Essen works a total horse power of over [illegible]3 000 is used this power operating over [illegible]000 separate machine tools over 900 cranes 18[illegible] trip hammers and 81 hydraulic presses

The bottoms of many Swedish lakes are covered to a thickness of six or eight inches with fragments of iron ore of the size of peas This lake ore consists chiefly of ochre or hydrated oxide of iron mixed with silicate and phosphate of iron clay sand and other impurities and yields pig iron of very good quality The ore is obtained by very primitive methods In winter a hole is cut in the ice a scraper attached to a long pole is inserted and all the ore within reach is collected into a heap beneath the hole Some of the mud which has been scraped together with the ore is removed by stirring the mass with poles and the ore is then scraped into bags which have been sunk and is hauled up In summer this curious mining operation is conducted in a similar manner from rafts anchored in the lake Two miners can bring up about four tons of ore in a day Steam dredges have recently been installed in a few places About thirty years after the removal of the ore a new layer of the same thickness is found to have been produced by natural chemical processes

A concrete jacket for a leaky concrete chimney has recently been put into use The chimney in question is 80 feet high and cylindrical for a greater part of its height with an inside diameter of 4 feet and a wall thickness of 4 inches It was built about five years ago out of dry porous concrete and for some time past has given trouble owing to the cracks and holes affecting the draught It was decided to jacket the whole outside with a [illegible] inch thickness of concrete reinforced with 32 vertical rods hooped with circumferential rods at 6 inch centers For the work a form was built of sheet iron made up of three equal segmental parts and [illegible] feet in height The three parts were joined together by bolts through vertical angles on the edges of the segmental plates To the forms a working platform was built and the whole contrivance hung by tackle from the top of the chimney and pulled up as concreting progressed A wrapping of asbestos felt was put around the old chimney to form an expansion joint between the old and new concrete and also to prevent the heat from the chimney drying out too rapidly the newly laid concrete First 5 feet of asbestos wrapping was placed then the reinforcing steel, then the form was pulled up over the section and the concrete deposited The next morning the process was repeated so that concreting was always done in the afternoon and the forms removed from it the following morning

SCIENCE NOTES

The ordinary form of liquid bath for the determination of melting points has been modified by the introduction of an air bubble system causing a rapid circulation of the liquid and hence a uniform temperature The same idea has been very ingeniously applied by Mr H Stoltzenberg—Zeitschrift für physikalische Chemie March 11th—in designing a low temperature cooling bath The liquid—pentane—is caused to circulate by means of hydrogen bubbles through a spiral dipped in liquid air ether and solid carbon dioxide or a mixture of ice and salt according to the temperature required and then passes into the vacuum jacketed vessel in which the measurements are carried out The temperatures can be easily regulated by altering the amount of the spiral immersed and can be kept very constant

The longitudinal pressure of a train of sound waves coming from a vibrating tuning fork may be readily shown as a lecture room experiment A torsion balance is made by a suspension of silk or quartz the beam being of fine glass tube 10 centimeters long with a thin piece of mica 2 or 3 centimeters square at one end balanced by soft wax at the other A mirror in the middle serves to show the deflection The whole is mounted in a box with tube for the suspension One side of the box should have a glass window and another covered with loosely stretched rubber dam through which a short heavy brass rod projects its cross section being equal to the size of the mica vane to which its end is parallel at the distance of 1 or 2 centimeters The stem of the vibrating fork is applied to the outer end of the brass rod which then receives longitudinal vibrations gives them to the air in the box and so affects the vane A Konig fork of 256 per second gave a deflection of 6 feet to 10 feet on a wall 20 feet distant The spot of light does not move for 2 or 3 seconds

Lehmann's attempts to produce artificial coloration in liquid crystals have proved that these crystals like solid crystals are incapable of absorbing foreign matter in a state of uniform molecular distribution Lehmann has also observed that combined or mixed crystals are formed very frequently by heteromorphous but very rarely isomorphous substances In a recent article Lehmann expresses the opinion that foreign molecules imprisoned in a crystal are arranged according to the crystalline system by the operation of the same directive forces that govern the arrangement of the molecules of the crystal itself and that any other distribution of such foreign molecules is impossible This theory accounts for the production of dictroism A crystal growing in a viscous mass or colloidal suspension eliminates the suspended particles This progressive elimination is very striking in the crystallization produced by cooling a hot saturated solution of para azoxyanisol in mono-bromo-naphthalene containing in suspension the minute globular spores of *Lycoperdon* An incomparably finer suspension is furnished by a commercial dye which is composed of triturated lampblack combined with fat or soap When a hot saturated solution of this dye is allowed to cool the fine particles of lampblack are eliminated and fill the interstices between the fat crystals which appear as perfectly transparent drops on a black background In view of the impossibility of maintaining colloids in uniform or irregular suspension in crystalline liquid Lehmann believes that such liquids like solid crystals possess a power of spontaneous purification and can be purified by repeated (liquid) crystallisation In almost all of the few cases in which Lehmann succeeded in coloring liquid crystals the regular arrangement of the foreign molecules was indicated by the appearance of dichroism This power of spontaneous purification may be employed as a criterion to distinguish crystalline from amorphous liquids A colloidal solution is necessarily amorphous

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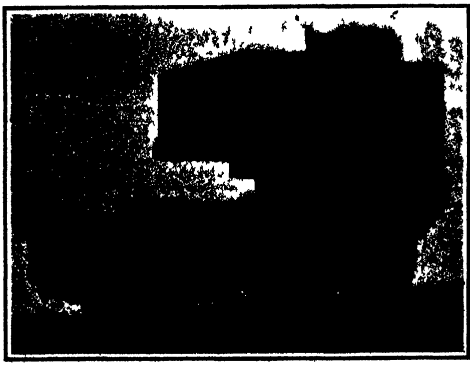
THE GARRATT FLEXIBLE RAILROAD LOCOMOTIVE.

By the English Correspondent of the SCIENTIFIC AMERICAN.

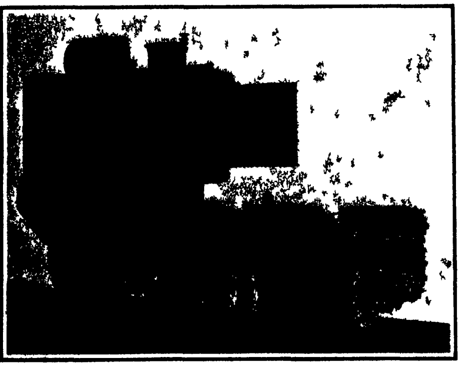
THERE has been constructed at the Manchester locomotive works of Messrs. Beyer, Peacock & Co., Ltd., a novel type of locomotive. The general principle of this new type, which has been designed by Mr. H. W. Garratt, M. I. Mech. E., may be gathered from a reference to the accompanying illustrations. Its salient features are its extreme flexibility and adaptability to operation upon steep grades and sharp curves combined with a maximum of adhesion effort.

The engine broadly comprises three fundamental units—the boiler and frame and forward and trailing bogies respectively, which can be attached to or detached from the boiler by means of couplings at either end of the main frame. The leading bogie is fitted with the low pressure cylinders, while the trailing bogie is equipped with the high pressure cylinders. This disposition, it may be pointed out, possesses many distinct advantages, for the boiler being centrally placed may be brought fairly low and the firebox may be made wide and deep for

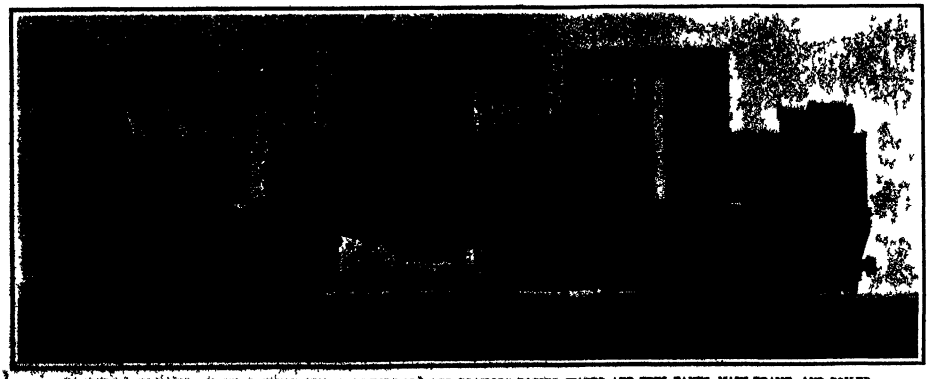
THE MAIN FRAME AND BOILER LIFTED CLEAR OF THE BOGIE TRUCKS



THE TRAILING BOGIE WITH HIGH PRESSURE CYLINDERS, 800-GALLON WATER TANKS AND BUNKER FOR ONE TON OF COAL.



THE LEADING BOGIE WITH ITS 510-GALLON WATER TANK, SHOWING CONNECTIONS AND LOW PRESSURE CYLINDERS



FLEXIBLE LOCOMOTIVE, SHOWING ARRANGEMENT OF FORWARD AND TRAILING BOGIES, WATER AND FUEL TANKS, MAIN FRAME, AND BOILER.

THE GARRATT FLEXIBLE RAILROAD LOCOMOTIVE.

there is no hamper beneath the frame such as axles to restrict the boiler and firebox dimensions Moreover the width and length of the boiler are not placed within such severe limits as at present obtain a feature which the locomotive engineer cannot fail to appreciate Also the whole weight of the engine is imposed upon the driving wheels so that the maximum adhesion effort is secured In negotiating curves as the three parts of the engine move independently the central part or main frame assumes a position analogous to the chord of the curve and the center of gravity of the whole engine is brought inward This enables far sharper curves than are possible with either duplex or articulated engines to be negotiated safely and without any of the drawbacks incidental to the usual foregoing types such as projection of the engine frame over the outer forward side of the front truck which factor on sharp curves is responsible for certain difficulties in coupling and uncoupling operations The two trucks accommodate themselves to the curve independently of the main frame and as these carry the coupling arrangements there is no more difficulty experienced on the minimum possible curve than upon a straight track

The engine shown in the accompanying illustration is one of a pair that has been constructed for the 19 mile stretch of the Northeast Dundas 2 foot gage tramway of the government railroad of Tasmania Owing to the severity of the grades and the numerous sharp curves which abound certain factors to suit the prevailing conditions had to be taken into consideration and the specification called for a compounding system which tended to render the mechanism somewhat complicated The system however is not necessarily a compound one and consequently its design an under ordinary circumstances be simplified

The boiler barrel mounted on the main frame has a length of 7 feet with a diameter of 3 feet 11 125 inches The heating surface is tubes 568 square feet, and the firebox 60 feet making a total of 628 feet while the grate area is 14 8 square feet The working boiler pressure is 19[illegible] pounds per square inch The frame built up of two main longitudinals plates angles etc is of rigid construction the boiler being fixed at the smokestack end while the usual provision is allowed for expansion at the firebox end The two bogies have four pairs of wheels disposed in two coupled groups and each group has a wheel base of 4 feet The cylinders are placed outside the truck frames with valves on top the gear being a modified Walschaert operated by a small return crank outside the main crank off the crosshead The high pressure cylinders on the trailing bogie have a bore of 11 inches by 16 inch stroke the piston valves having inside admission while the low pressure cylinders on the forward bogie are of 17 inches diameter by 16 inch stroke the steam admission being outside The total wheel base of the engine is 2[illegible] feet 9 inches and the over all length 33 feet 10 5 inches with a width of 7 feet

The front truck carries a water tank with a capacity of [illegible]10 gallons and the rear truck another smaller tank of [illegible]10 gallons capacity together with bunker space for one ton of coal With fuel and water tanks full in running order the total weight is 33 tons 10 [illegible] hundredweight divided as follows Seventeen tons [illegible] hundredweight on trailing truck and 16 tons [illegible]2 hundredweight on leading truck

Owing to compounding the steam arrangements are somewhat intricate the steam being taken from the boiler to a point in front of the trailing truck to a ball joint exactly below the truck center then for a short distance forward where it is bifurcated and led to the high pressure cylinders on either side of the truck The exhaust from the cylinders is carried through a Y pipe to a central ball joint whence extends a longitudinal receiving pipe fitted with a sliding joint to the forward bogie where it is conveyed through another ball joint and intercepting valve by short branches leading to the cylinders on either side The exhaust from the low pressure cylinders is led off to a single pipe fitted with a ball and socket joint into another pipe having a sliding joint into the blast pipe The intercepting valve on the leading bogie is controlled from the engineer s cab so that when compounding the receiving pipe from the high pressure cylinders is in communication with the low pressure cylinders In simple working the receiver is placed in direct communication with the blast pipe as the steam passage to the low pressure cylinders is closed by the intercepting valve and live steam is supplied to the low pressure cylinders One reversing lever by a simple motion controls both bogies and ample braking arrangements connected to both trucks are also fitted The detachment of the main frame and boiler from the bogies is a simple operation It is only necessary to disconnect pipes rods and so forth lift the central part a few inches and the truck can be pushed clear of the main frame without touching the truck tanks in any way

These engines have been designed to work on grades up to a maximum of 4 per cent and on curves of only 99 feet radius The preliminary trials at the builders works amply demonstrated the easy and steady riding of the engine The coefficient of adhesion with tanks full is [illegible]3 and 4 5 with the tanks empty

TUNGSTEN ORES.

HOW THEY ARE MINED IN SPAIN.

WORKINGS OF THE MINES AND USES OF THE METAL

IN answer to an inquiry from a Pittsburg company Consular Agent Harry A McBride of Bilbao furnishes the following information concerning the tungsten mines of Spain

The highly valuable form of tungsten ore known as wolframite is found in the Spanish provinces of Pontevedra Corunna Orense Salamanca and Caceres A lower grade of tungsten is also found in the province of Cordoba but in very small quantities

Mines have but recently been opened and the exportation of the ore began about 1[illegible]0 Owing to the mountainous character of these provinces the distance of the mines from the railroads and the expense of machinery and fuel the mining in order to be profitable must be done on a very large scale and at present only one company (an English company) is working with modern machinery and raising important quantities of ore This firm owns several mines in Pontevedra Corunna and Orense the most important being the mines at Carbuelia Pontevedra and those at Noya Corunna These mines produce from 200 to [illegible]00 tons of wolframite per year (about four fifths of the entire Spanish output) all of which is exported to England The other mines in these provinces are insignificant producing annually from one to five tons

The principal mines in Salamanca, the second of importance in Spain are near the village of Barruecopardo in the northeastern part of the province and are owned by a German firm These mines extend over [illegible]0 acres of ground and as yet only the surface ore has been touched of which from 40 to 50 tons have been obtained annually since 1904 This amount has all been bought by German firms The production for the first two months of 1910 was 11 tons Borings having been made to a depth of 98 feet and the richness of the territory proven the firm is now endeavoring to secure sufficient capital and estimates that about $4[illegible]000 will be necessary to properly work the mine

MINOR OPERATIONS QUALITY AND ANALYSIS

Other mines in Salamanca are at Navasfrias in the southwestern part of the province very near the Portuguese frontier from which about 20 tons in all have been obtained There are several other small mines of very little importance The principal mines of Caceres are in the northeastern part of the province near the Navasfrias district and only a few miles distant from Portugal The annual production of the remaining mines of this province does not exceed two or three tons The mines are small and owned by stock companies composed of large numbers of the farmers of that vicinity who ask exorbitant prices for their shares making exploitation almost impossible

The quality of the wolframite obtained from these provinces is of the highest and analysis of the ore just as it is raised averages from 60 to 65 per cent pure In the form of concentrates the average is from 68 to 72 per cent Generally the ores from Northern Salamanca average the highest

In combination with the wolframite from the provinces of Salamanca and Caceres arsenical pyrites (mispickel) is found in large quantities In the Navasfrias and Acebo mines the two minerals are so thoroughly mixed that it is necessary to burn out the arsenic in order to make the wolframite marketable Farther north in the Barruecopardo district the formation is quite different Here the arsenic is also found in large quantities but it comes separated from the wolframite and makes a valuable addition to the products of the mines Several tons have been exported at various times Pieces of pure arsenical pyrites two feet square have been found here In Pontevedra Corunna and Orense no arsenic is found but quantities of tin are mixed with the wolfram ores

The entire Spanish production of tungsten ores is exported none being manufactured in this country

Just over the Spanish boundary in the Portuguese province of Biera Baja (Castelho Branco district five miles from the town of Silvares) are located two important mines owned by a London company This company was formed in 1908 with a capital of £100 000 ($486 650) and has erected mills turbines electric and gas plants shops etc costing $90 000 The property consists of 1 2[illegible]6 acres of land and is only a few miles from the Navasfrias and Acebo mines The quality and formation of the ore is precisely the same as that taken from the Spanish mines above mentioned The following article taken from the prospectus of this company as published in a London newspaper may be interesting

WORLD S OUTPUT OF TUNGSTEN AND ITS USES.

The world s output of high-grade wolfram ore is limited and is estimated to average about 4 000 tons over the past four years Apart from the use of wolfram for chemical purposes, the demand for wolfram for the manufacture of high-speed tool steel is very large and steadily increasing The use of wolfram steel for motor cars is becoming general in cars of high-class manufacture particularly by the French makers Wolfram is also used in the manufacture of electric lamps

The manufacture of wolfram metal, which is also known by its trade name of tungsten metal has been almost exclusively in the hands of German manufacturers consequently the large English steel works manufacturing ordnance gun forgings, armor plate and high-speed tool steel and other forms of steel in which wolfram is employed have always had to depend on the foreigner for their supplies of metal. It is proposed at a later date to establish works to convert this company s output into tungsten metal which should be a source of further large profits

The article also states that the cost of producing wolframite is $272 per ton—Weekly Consular and Trade Reports

SOLDERS FOR VARIOUS METALS

SOLDERING is divided into two classes namely hard and soft soldering Ordinarily soldering with a heated copper bit employs soft solders – alloys of tin lead etc which melt at comparatively low heats The use of the blowpipe makes possible the employment of hard solders which are alloys of silver copper zinc etc and melt at a very much higher temperature than the soft solders The hard soldering of copper iron etc, is generally known as brazing and the solder as spelter

It must always be borne in mind that both soft and hard solders deteriorate with age if kept for a long time in a damp atmosphere For electrical work ingredients such as mixtures of vaseline rosin glycerine and chloride of zinc are used as non-corrosive fluxes. The accompanying table gives the composition of both soft and hard solders that are suitable for various metals.—A Eyles, in Machinery.

Soft and Hard Solders for Various Metals

Metal to Be Soldered	Flux	Soft Solder		
		Tin	Lead	Other Constituents
Aluminium	Stearin	70		Z* 25 A* 2 P* 3
Brass	Chloride of zinc rosin or chloride of ammonia	66	34	
Gunmetal	Chloride of zinc rosin or chloride of ammonia	63	37	
Copper	Chloride of zinc rosin or chloride of ammonia	60	40	
Lead	Tallow or rosin	33	67	
Block tin	Chloride of zinc	99	1	
Tinned steel	Chloride of zinc or rosin	64	36	
Galvanized steel	Hydrochloric acid	55	45	
Zinc	Hydrochloric acid	55	45	
Pewter	Gallipoli oil	25	25	B* 50
Iron and steel	Chloride of ammonia.	50	50	
Gold	Chloride of zinc	67	33	
Silver	Chloride of zinc	67	33	
Bismuth	Chloride of zinc	33	33	B* 34

* Z = zinc. A = aluminium P = phosphor tin. B = bismuth.

Metal to Be Soldered.	Flux.	Hard Solder			
		Copper	Zinc	Silver	Gold.
Brass, soft.	Borax.	[illegible]	78		
Brass, hard.	Borax.	[illegible]	55		
Copper	Borax.	[illegible]	50		
Gold	Borax.	[illegible]		[illegible]	[illegible]
Silver	Borax	[illegible]	[illegible]	[illegible]	
Cast iron	Cuprous oxide.	[illegible]	[illegible]		
Iron and steel	[illegible]	[illegible]	[illegible]		

REORGANIZATION OF AMERICAN FARMING.*

INTENSIVE CULTIVATION THE GOAL.

BY PROF. HOMER C. PRICE, OHIO STATE UNIVERSITY.

FROM the beginning American agriculture has been characterized by its extensiveness rather than its intensiveness Land has been more abundant than labor and in the aggregate more has been derived from a small yield on a large acreage than could have been realized from a large yield on a small acreage The yields of American farm crops have been proverbially small but the total production has been exceptionally large and as a rule the countries producing the largest amounts of farm crops have the smallest yields per acre This fact is illustrated in the following table

	Average Yield per Acre, 1888 1897	Average Yield per Acre, 1898 1907	Total Production
	Bushels	Bushels	Bushels
United Kingdom	30 1	33 6	55 585 000
Germany	22 7	28 4	138 442 000
France	17 6	20 8	310 596 000
United States	13 8	13 9	664 602 000

The above table also reveals the fact that the production per acre when compared by ten year periods has been increasing in all the countries Much has been said and is being written about the decline in agricultural production but statistics do not show that there has been any decline but rather a marked increase when the productions of the leading countries are compared and using the production of wheat which is the most universally grown farm crop as the basis for comparison

The intensity of culture always bears a direct relation to the density of population and while it is difficult to get a comparable basis of comparison between countries on account of the varying proportions of waste land in different countries and different methods of classifying statistics the following table represents the most reliable figures available and when compared with the preceding table shows that the yield of wheat per acre varies directly as the density of population

Number of Acres per Capita

United Kingdom	1 70 acres
Germany	2 37 acres
France	2 40 acres
United States (exclusive of Alaska and Philippines)	24 02 acres.

In 1900 there were 838 000 000 acres in farms in the United States and since then we have been adding to them about 15 000 000 acres each year from the public lands of the country During this time however the population of the country has been increasing at the rate of about one and one half million each year The public lands of the country that are suitable for agricultural purposes have practically all been taken up the tide of immigration has been turned back from the Pacific coast and the competition for land already under cultivation has become much more keen and as a consequence the values of farm real estate have advanced generally throughout the country but to the greatest extent in the western States Farm lands in some sections have doubled or even tripled in value in the course of a few years

Together with the increased value of farm lands have gone other changes that have had an important bearing on the agriculture of the country

The development of methods of transportation and the extension of railroads through the new agricultural lands have widened the markets of the country for both buying and selling The introduction of refrigerator car service has made possible the shipping of fruits meats and other perishable products across the continent This has resulted in bringing the products of cheap lands in competition with the products of high priced land in the eastern States

Another factor that has had an important bearing in this connection has been the development of labor-saving farm machinery If the present wheat crop of the United States were harvested by the method employed at the time of the civil war it would require every man of military age in the United States to work for at least two weeks in wheat harvest The invention of labor-saving machinery has increased the producing power of the individual to such an extent that notwithstanding the increase in the agricultural exports of the country from $205,852 748 in 1858 to $1,017,396,404 in 1908, the percentage of the population engaged in agriculture has decreased by decades as follows:

1880	44 3 per cent
1890	37 7 per cent
1900	35 7 per cent

But notwithstanding the constant decrease in the proportion of the population engaged in agriculture the per capita production for the entire population of the most important classes of agricultural products has increased almost invariably

The following table gives the average per capita production by decades 1866 1905 These statistics are from the United States Department of Agriculture

Products	Decade.				Period
	1866 1875	1876 1885	1886 1895	1896 1905	1906 1908
Wheat bushels	6 2	6 3	7 4	7 8	7 9
Corn bushels	24 6	30 3	27 5	28 4	31 8
Oats bushels	6 9	9 1	10 7	10 6	9 8
Barley bushels	0 7	0 9	1 1	1 3	1 9
Rye bushels	0 5	0 5	0 4	0 4	0 4
Potatoes bushels	3 0	3 9	3 0	3 1	3 4
Cotton pounds	37 8	51 4	57 8	65 5	70 0
Hay tons	0 63	0 76	0 86	0 76	[illegible] 4
Horses number	0 20	0 21	0 23	0 20	0 23
Milch cows number	0 25	0 24	0 25	0 22	0 24
Other cattle number	0 37	0 4	0 55	0 49	0 55
Swine number	0 69	0 5	0 78	0 58	0 64
Sheep number	0 83	0 84	0 68	0 63	0 64

This almost inconceivable increase in agricultural production has been accompanied by changes in agricultural conditions that make a reorganization of American farming methods absolutely necessary

Foremost among these changes has been the growth of cities from an urban population of 2 897 000 or 12 5 per cent of the population total in 1850 to a population of 24 992 000 or 33 1 per cent of the total population in 1900 This concentration of the population has brought about new problems of food supply in furnishing the more perishable products such as milk vegetables fruits and such products as need to be consumed soon after production

Another condition that has arisen is the tendency of the soil fertility of the farms of the older agricultural sections to become exhausted To remedy this the use of commercial fertilizers has become general in the eastern United States and the statistics of 1900 show that $55 000 000 worth of goods were used by the farmers of the United States which was an increase of 42 per cent over the amount used in 1890 so that it is probable that not less than $75 000 000 per year is spent for this purpose

The opening up of the Middle West took from the farmer of the eastern States his market for wheat and other grain He was thrown in competition on the open market with the farmer who had secured his land for practically nothing and land that was much more fertile and productive The farmer of the Middle West in turn has been thrown in competition in the live-stock markets with the live stock products of the western and southwestern States and Territories Stock that was raised under range conditions and often on government land free of charge competed with stock raised on high priced farms of the Middle West

While these conditions are not so emphatically true as they were a few years ago yet the problem is far from being solved and the American farmer is now passing through a transitional stage and the most important problem before him at the present time is the question of reorganizing his farming methods so as to best fit the agricultural conditions as they now exist

The unprecedented increase of values of farm products in recent years resulting in a greatly increased cost of living to every one has resulted in the most prosperous times the American farmer has ever experienced except during the civil war by those who stayed at home and reaped the benefits of high prices

The consumer on the other hand is alarmed at the continued rise in price of the necessities of life He is interested in knowing what the end is going to be and how much longer prices are going to rise

Writers who are ill advised of the potential producing power of American farms are freely predicting that we are rapidly approaching the time when as a nation we shall not be able to produce sufficient food stuffs for our own population They forget that our farms are not producing more than one half of what they are capable of doing Our average wheat yield is 14 bushels per acre our average yield of corn is 26 bushels and of oats 25 bushels, these yields can and will be doubled in the future as the high price of the products will demand

The profits of farming in the past gained from actual production have not been in proportion to the profits derived from other industries The market price of farm products has tended toward the actual cost of production of the average crop at current wages rather than the cost of production of the part of the crop produced under the most unfavorable conditions This is readily demonstrated by taking the actual amount of time required to grow and harvest an acre of any of the principal crops and calculating the time at current wages and the average yields at farm prices

The results will show that the returns received for the time spent will not be more than enough to pay current wages and six per cent interest on the investment in land and equipment Farmers have received greater returns from the increased value of their lands than they have from the profits upon their productions

The increased prices of farm products are beginning to bring to farmers a just return for labor expended and will do more than anything else to turn the city dweller back to the soil and to keep the country boy on the farm There is no danger of a shortage of food supplies in this country but higher prices must prevail in order to develop the potential agricultural resources of the country Aside from the possibilities of doubling the present crop production on present area under production there remains the undeveloped agricultural lands of the country Aside from the limited amount of land suitable for agricultural purposes remaining in the ownership of the government the lands that may become valuable for agricultural purposes are of two kinds—the swamp lands that may be reclaimed by drainage and the arid lands that may be reclaimed by irrigation The United States Geological Survey estimates that 7 000 000 acres can be made valuable for agriculture by drainage swamps This is the equivalent of one sixth of all the land now under cultivation in the United States This land would be much more fertile and much more productive than the most of the land that is now being cultivated The reclamation of arid lands is just in its infancy The first federal act to provide for government assistance for this purpose was passed in 1902

Projects are now under construction or have been completed that will reclaim one and a half million acres and others are under consideration that will reclaim three and one half million To what extent this work of reclamation will be carried in the future can scarcely be estimated but doubtless many millions of acres can be and will be added to our cultivable lands in the future

The period of low prices for farm products and extensive methods of farming is rapidly passing The large grain and live stock farms of the eastern States are giving way to the smaller dairy fruit vegetable or poultry farm The large wheat farms of the North west are being divided into moderate-sized farms for mixed farming The ranges of the West and South west are being broken up into stock farms and the movement everywhere is toward more intensive methods of farming

The problem that now confronts the American farmer is to reorganize his method of farming so as to adapt it to the present conditions The increased prices for farm products will increase their production and insure a supply sufficient for all needs for the future

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The new Japanese law for the encouragement of native shipbuilding came into operation with the beginning of this year and includes provisions according to which in the construction of the hull or the machinery for a vessel which is to receive a subsidy foreign made materials must not be used except for the following parts viz Stem, stern post rudder and rudder tiller rudder post quadrant and rudder pintles used for vessels of 3 000 tons or more triple screw shaft bearing stanchions of not less than [illegible] inches diameter all kinds of springs corrugated and plain or flanged furnaces, rotor spindle or shaft blades and buckets of turbine engine The following articles used in the equipment of a vessel which is to enjoy the subsidy must not be foreign made viz Windlass cargo winches steering engine and gear anchor chains wire ropes hawsers etc centrifugal pumps hand pumps fire pumps boat and other davits electric apparatus auxiliary condenser steam pumps dynamo valves and cocks Patented articles or articles of new design made abroad can only be used in the construction of hull or machinery or in the equipment of a ship receiving a subsidy with the special permission of the Minister of Communication.

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* Popular Science Monthly

REMARKABLE COMETS.*

COMETS OTHER THAN HALLEY'S.

The comets which might be included in a list with the adjective remarkable attached to it are very numerous and I shall for the most part treat the word remarkable as applying rather to naked eye peculiarities and splendor than to physical peculiarities revealed only by the use of the telescope I must therefore limit myself to a selection premising that Grant included the following as proper to be classed as remarkable

1066
1106
114
1265
1378
1402
1456
1531
[illegible]
1577
1607
1618
1661
1680
1668
1689
1729
1744
1759
1769
1811
1823
1845
1843
1858
1861

Grant's list was if I remember right put forth in a lecture which he gave at the Royal Institution in 1870 and the additions which should be made to it to represent the period 1870-1909 are singularly few the chief of them being the comet of 1874 (III) best known as Coggia's comet and the comets of 1881 (III) and 1882 (III) but the large comets which appeared in the Southern Hemisphere in 1880 (I) 1887 (I) and 1901 (I) have some claim to notice By the law of averages a good bright comet is now more than overdue and it remains to be seen whether Halley's when it attains its brightest development in 1910 will come up to the required standard

The extravagant language used by the old writers and the *bizarre* character of the drawings which they have left behind them render it doubtful how far it is wise to attempt to reproduce either their words or their pictures I will therefore start no farther back than the middle of the eighteenth century in my endeavor to present the reader with authentic information and authentic pictures of some comets of special importance

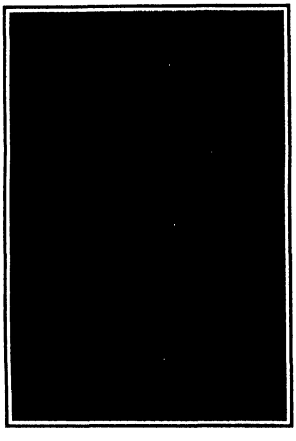
Although it is commonly considered that Donati's comet of 1858 (presently to be described) is the most beautiful (though by no means the largest) on record I cannot help thinking that De Chéseaux's comet of 1744 with its many and very large tails should receive the palm for striking beauty The recorded descriptions of these tails are however not very detailed

This comet was long under a cloud (metaphorically) because nobody seemed inclined to believe that the only drawing and description of it, with its six tails, known till recently to be extant, could be true depending as it was supposed to do on the testimony of one man and he of no particular astronomical standing while other astronomers of repute mentioned the comet but made no allusion to its many tails However all distrust of this man's honesty must now be regarded as unreservedly withdrawn, ample confirmatory testimony having been brought to light as recently as 1864

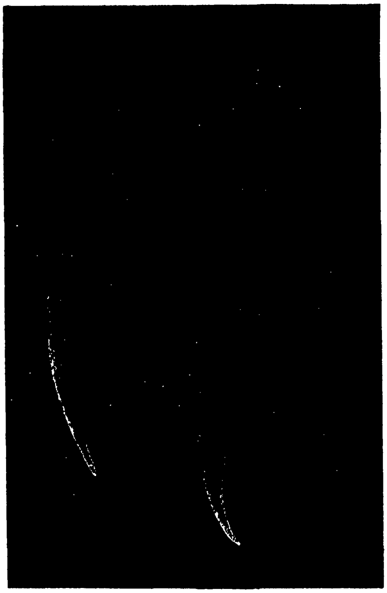
The circumstances under which this came about are sufficiently curious Winnecke in the year named unearthed at St. Petersburg some records of MS by the French astronomer Delisle in which the fact of this comet having had several tails was clearly stated He also found in an anonymous pamphlet printed at Berlin in 1744 and edited it would seem by the well known mathematician L. Euler a very detailed description of the comet and its multiple tail fully confirmatory of De Chéseaux's account and written by a lady member of a well known German astronomical family Fräulein Margaretha Kirch †

De Chéseaux has left the following description (translated from the French) of this comet

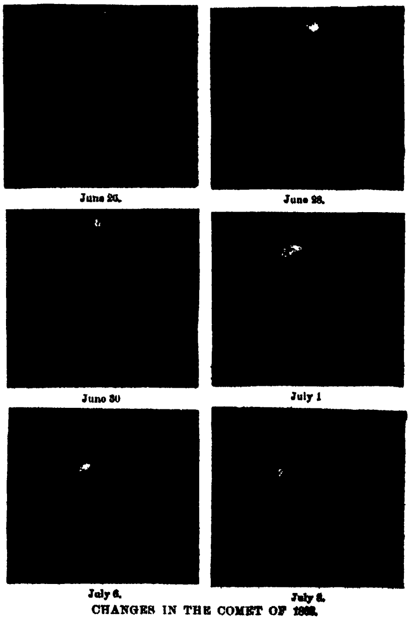
It appears certain from all the observation up to March 1st that if this comet had appeared under more favorable circumstances e g in the middle of a night instead of so near the setting sun and also clear of moonlight it would have been a more striking comet than had ever been known alike from the size of its head and from the length of its tail which up to this time had been simply double but something much more surprising was in store for us The sky was quite overcast from the 1st to the 7th of March but on this last named day the clouds became broken and gave us some hope of seeing the comet's tail I prepared myself for seeing over again just about what I had seen during the closing days of February At 4 o'clock on the morning of March 8th I went down stairs with a friend into the garden with the east facing us. This friend walking in front of me startled me by saying that instead of two tails there were five I hardly believed him but after having passed from behind several buildings which had partly concealed the eastern horizon from me I did indeed see five tails in the form of whitish rays lying one above the other obliquely above the horizon up to a height of 23 deg and of about the same breadth in all These rays were each about 4 deg in width but they became narrower toward their lower extremities. Their edges were sufficiently distinct and rectilinear Each ray was made up of three bands; the middle one was darker, and double the width of the bands forming



COMET A, 1910



DONATI'S COMET OCTOBER 5 AND 9, 1858.



June 20. June 28. June 30 July 1 July 6. July 8.

CHANGES IN THE COMET OF 1908.

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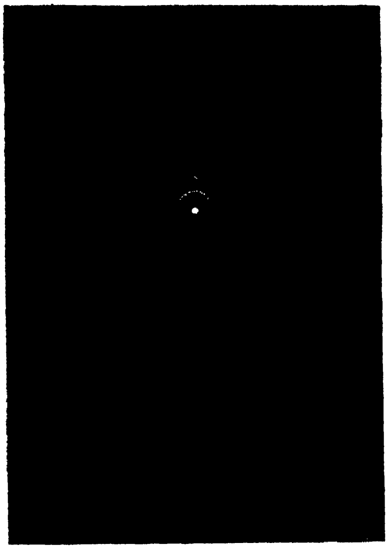
* The Story of the Comets Simply Told for General Readers By George F Chambers F R A S Oxford at the Clarendon Press 1909

† All this story is fully set out by J. W. L. Dreyer in the Copernicus Magazine, vol. III., p. 104, 1884, accompanied by diagrams.



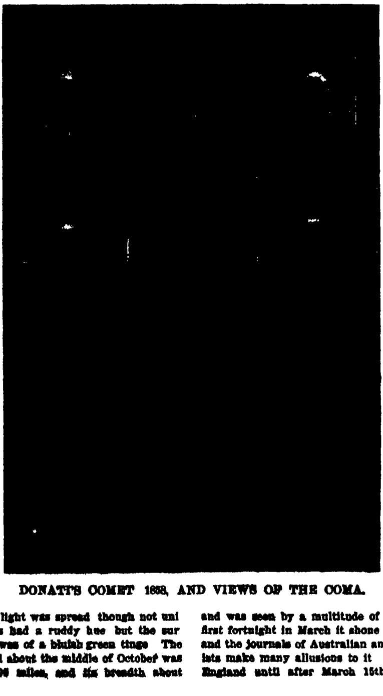
COGGIA'S COMET, 1874, ON JULY 18

the edges These last named resembled precisely the brightest portions of the Milky Way between Antinoüs and Sagittarius, and between Ophiuchus and Scorpio The interval between the chief rays was dark like the rest of the sky; however, at the bottom there was some luminosity resembling that at the extremity of these rays as if we were looking at the tips of other rays of shorter length Besides these five tails edged by white bands there was a sixth in which one noticed no bands, perhaps because it was low down This sixth tail joined to the ten brighter bands of the others presented the appearance of there being eleven rays in all."

De Chéseaux goes on to make some comments which seem rather intended as a reply to certain persons who had criticised unfavorably the idea that the object which they had been looking at was really a comet After referring to the fact that eighteen persons had seen the comet at Lausanne and several at Berne but that bad weather had prevented any observations at Geneva or Paris, he says Astronomers must judge for themselves whether the phenomenon described was that of a celestial body and if it could have been possible that any merely atmospheric phenomenon could have maintained steadily during twenty four hours its condition unchanged its size and color the same, its position with respect to the fixed stars the same, and have participated with them in the diurnal movement.' De Chéseaux reckons his twenty four hours from the night of March 7th and 8th to the following night of March 8th and 9th after which he never saw the comet again He adds that "the sky was very serene without the least cloud or haze and that both sun and moon (to one or other of which only could the phenomenon be ascribed if it was only atmospheric) were both of them too far away from the point of convergence of the tails " He then offers some further remarks directed to show that if the rays were tails of a comet, which had its head below the horizon, everything would be explained satisfactorily.

The comet of 1811 (I.), is one of the most celebrated of modern times. It was discovered by Flaugergues at Viviers on March 25th, 1811, and was last seen by Wisniewski at Neu-Tscherkask in the south of Russia on August 17th, 1812 a visibility of seventeen months—a period then unprecedented It was a result of this long visibility that owing to the earth s annual motion, the comet twice disappeared in the sun's rays, and twice reappeared after having been in conjunction with the sun In the autumnal months of 1811 it shone very conspicuously with a bright nucleus and tail, which became visible soon after sunset and continued visible throughout the night for many weeks, owing to its high northern declination. The extreme length of the tail is stated for the first week in October, and was about 25 deg., with a breadth of about 6 deg. Throughout [illegible] in August, the tail, according to [illegible] [illegible] [illegible] which was

nearly at a right angle to each other Sir W Herschel paid particular attention to this comet and his observations are of great value He states that it had a well defined planetary disk by way of nucleus which was involved in the nebulosity forming the head From this measurement he calculated that the diameter of the nucleus was 428 miles When examined with high powers the stellar character of the nucleus disappeared, and the light was spread though not uniformly The nucleus had a ruddy hue but the surrounding nebulosity was of a bluish green tinge The real length of the tail about the middle of October was upwards of 100,000,000 miles, and its breadth about 15 000 000 miles This comet is undoubtedly a periodical one Argelander whose investigation of the orbit is the most complete assigned to it a period of 3 065 years subject to an uncertainty of only forty three years The aphelion distance is fourteen times that of Neptune or say 40 000 000 000 miles



DONATI'S COMET 1858, AND VIEWS OF THE COMA.

The comet of 1843 (I) was another very celebrated comet and I once came upon the following remarks made by one who had seen Donati s comet of 1858 as well as that of 1843 and was able to compare the one with the other Gen J A Ewart wrote thus of the comet of 1843

It was during our passage from the Cape of Good Hope to the equator and when not far from St. Helena that we first came in sight of the great comet of 1843 In the first instance a small portion of the tail only was visible at right angles to the horizon but night after night as we sailed along it gradually became larger and larger till at last up came the head or nucleus as I might properly call it It was a grand and wonderful sight for the comet now extended the extraordinary distance of one third of the heavens the nucleus being perhaps about the size of the planet Venus

Gen Ewart thus speaks of Donati s comet of 1858

A very large comet made its appearance about this time and continued for several weeks to be a magnificent object at night *it was however nothing to the one I had seen in the year* 1843 when on the other side of the equator

Writing from the Cape of Good Hope on November 12th 1843 to his friend Admiral Smyth Mr (afterward Sir Thomas) Maclear said

Of the casual observatory phenomena the grand comet of March takes precedence and few of its kind have been so splendid and imposing I remember that of 1811 it was not half so brilliant as the late one

So far as I know this is the only account which has ever appeared in print written by one who had had the chance of seeing both comets and was capable of scientifically appraising them Sir John Herschel would have seen all three of these bodies (1811 1843 1858) but he does not appear to have left behind him any remarks on the earliest one This may not be extraordinary seeing that he was only an undergraduate at Cambridge and only aged 19 when the comet appeared and that he did not start his astronomical career until five years afterward The comet of 1843 was first seen in the Southern Hemisphere in the last week of February but nobody can be named as its first discoverer because it displayed itself suddenly, and was seen by a multitude of persons During the first fortnight in March it shone with great brilliancy and the journals of Australian and New Zealand colonists make many allusions to it It was not visible in England until after March 15th, when its splendor had much diminished but the suddenness with which it made its appearance to observers in the Northern Hemisphere as it had done in the Southern added not a little to the interest which it excited. The general length of the tail during March as seen in the Northern Hemisphere was about 40 deg and its breadth about 1 deg.

The orbit of this comet is remarkable for its small perihelion distance which according to the most trustworthy calculation did not exceed about [illegible]00 000 miles and the immense velocity of the comet in its orbit when near perihelion occasioned some extraordinary peculiarities. Thus between February 27th and February 28th it described upon its orbit an arc of no less than 292 deg. Assuming its true orbit to be elliptical as we are entitled to do this would leave only 68 deg to be described during the time which would elapse before its next return to perihelion. Various attempts have been made without any very definite measure of success to identify this comet with others which have gone before but this is a matter which belongs to a previous chapter.

The comet of 1858 (VI). On June 2nd in that year G. B. Donati of Florence descried a faint nebulosity slowly advancing toward the north and near the star λ Leonis. Owing to its immense distance from the earth (something like 240 000 000 miles) great difficulty was experienced in laying down its orbit. By the middle of August however its future course and the great increase in its brightness which would take place in September and October were fairly foreseen. Up to August it had remained a faint object not discernible by the unaided eye. It was distinguished from ordinary telescopic comets only by the extreme slowness of its motion (in singular contrast to its subsequent career) and by the vivid light of its nucleus. It has well been said that the latter peculiarity was of itself prophetic of a splendid destiny. Traces of a tail were noticed on August 20th and on August 29th the comet was faintly perceptible to a keen unaided eye but it was not until September 3rd that I so saw it. For a few weeks the comet occupied a northern position in the heavens and it was therefore seen both in the morning and in the evening. On September [illegible]th a slight curvature of the tail was noticed which subsequently became one of the most striking features. On September 17th the head equaled in brightness a star of the 2nd magnitude, the length of the tail being 4 deg. The comet passed its perihelion on September 29th and was at its least distance from the earth on October 10th. Its rapid passage to the Southern Hemisphere rendered it invisible in Europe after the end of October but it was followed at the Santiago de Chili and Cape of Good Hope observatories for some months afterward being last seen by Sir T. Maclear at the latter place on March 4th 1859. Its early discovery enabled astronomers while it was yet scarcely distinguishable in the telescope to predict some months in advance its approaching brilliancy and thus the comet was observed with all the advantage of previous preparation and anticipation. The perihelion passage occurred at the most favorable moment for presenting the comet to good advantage. When nearest the earth the direction of the tail was nearly perpendicular to the line of vision so that its proportions were seen without foreshortening. Its situation in the latter part of its course afforded also a fair sight of the curvature of the train which seems to have been exhibited with unusual distinctness contributing greatly to the impressive effect of a full length view. This comet, though surpassed by many others in size has not often been equaled in the intense brilliancy of its nucleus and the unusual, and so to speak artistic conformation of its tail which features the absence of the moon in the early part of October enabled spectators to view to the very best advantage. The passage of the comet in front of Arcturus on October [illegible]th will ever remain treasured in the memory of those who saw it. There is no doubt that Donati's comet revolves in an elliptic orbit the period of which has been variously estimated at 18[illegible], [illegible]040 and 21[illegible] years and Kritzinger thinks it may be identical with a great comet which is recorded by Seneca as having appeared in B. C. 146 and dated by the Chinese for the month of August in that year.

The head of Donati's comet deserves some special description because of the changes which it underwent and which have already been mentioned as features which often characterize very large comets. Bond first noticed on September [illegible]0th envelopes two in number above the nucleus the outer one at a distance of 16 seconds above the nucleus, and the inner one about 8 seconds. The outer one disappeared on September 30th at the height of about 1 minute. Meanwhile a third had appeared the one originally second having gradually expanded so as to take the place of the first. Seven successive envelopes in all were seen to rise from the comet, the last one starting on October 20th, when all the others had been dissipated. It was calculated that the envelopes moved upward at the general rate of something like 30 miles an hour. The first one rose to a height of about 18,000 miles, when it wasted away, but none of the others reached so far disappearing at elevations lower and lower, the last being lost sight of at an elevation of about 6 000 miles.

The following is a table of the dimensions* of the comet's nucleus and tail, at the undermentioned dates †

Date 1858		Diameter of Nucleus ″ Miles	Length of Tail Miles
July	13	[illegible] = 5 600	
August	30	6 = 4 660	2 = 14 000 000
September	8	3 = 1 980	4 = 16,000 000
	12		6 = 19,000 000
	23	3 = 1 [illegible]80	5 = 12 000 000
	25		11 = 17 000 000
	27		13 = 18 000 000
	28		19 = 26 000 000
	30		22 = 26 000 000
October	2		2[illegible] = 27 000 000
		1 = 400	33 = 33 000 000
	6	3 0 = 800	40 = 4[illegible] 000 000
	8	4 4 = 1 120	50 = 43 000 000
	10	2 5 = 630	60 = 51 000 000
	12		45 = 39 000 000

It has been calculated that at perihelion Donati's comet travels at a speed of 30 miles a second but that at aphelion its speed is only 234 yards a second.

(To be continued.)

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* These measurements must be read in the light of the caution that all dimensions given in miles depend on the old value (8 57″) of the sun's parallax. The probable value is now regarded as 8 8″.

† G. P. Bond Math Month Mag., Boston U S Nov and Dec 1858. He subsequently published a magnificent volume of notes and pictures relating to this comet forming vol III of the Annals of the Harvard College Observatory Cambridge, Mass 1862.

THE BODY'S GROWTH.*

SOME INTERESTING PHASES.

In one of his ironical moments Hazlitt has written "If you do not know the muscles by the help of which you walk how is it you do not fall down at every step you take?" The paragraph in which this sentence occurs was written by Hazlitt to emphasize the importance of intuition as contrasted with reason in the general conduct of life. But there can be little doubt that a scoffing sentence of a similar sort might be written to indicate the attitude of mind that most people adopt toward what is supposed to be peculiarly scientific information. It is indeed remarkable how very reluctantly scientific knowledge is adopted as a factor in their mental development by those whose education does not terminate abruptly when they leave school. The changes that have been introduced into our methods of education as a consequence of more enlightened ideas regarding the art of teaching have not been altogether free from mistake and even the present generation stands under the reproach of Herbert Spencer who declared that men who would blush if caught saying Iphigenia instead of Iphigenia or would resent as an insult any imputation of ignorance respecting the fabled labors of a fabled demigod show not the slightest shade in confessing that they do not know where the Eustachian tubes are what are the actions of the spinal cord what is the normal rate of pulsation or how the lungs are inflated. But probably the diffidence with which a layman approaches a subject of a scientific nature is a result of that strange and formidable vocabulary that necessarily grows around any specialization of knowledge and had these notes been entitled "An Outline of Postembryonic Ontogeny" I question if any editor of a general magazine would have deigned to consider even the first of my sentences.

I have chosen the simple title above, not as a subterfuge to lure the editor but as an indication of the manner in which I propose to relate a few of the changes that take place in the human body in the course of its growth toward maturity. Certain of these changes are of great interest to the general reader and it is my aim here to give a short account of them in ordinary language.

Many readers of this article will be able to recall to mind that masterpiece of ancient statuary the group of the Laocoon where a father with his two sons is crushed to death in the folds of two gigantic serpents. To judge from the difference in height between the father and his sons the figures of the latter are meant to depict mere boys. Yet there is nothing boyish about the figures. They are only diminutive men and one receives the impression that the master who gave this wonderful group of statuary to the world was in the habit of thinking of children as men in miniature. But even those who realize that a man or a woman is not merely an enlarged child seldom fully appreciate the extent to which the growth of the body is a process of metamorphosis. In respect of at least one organ the mature individual has lost something of the physical endowment with which he entered the world. When a child is born its little chest contains a bulky organ of which grown men and women can show but the merest trace. It is the thymus gland, it lies just over the heart and is a double lobed body of a pinkish color. In a baby this gland is generally large enough to extend from the heart up to the neck. When the baby has completed its second year the gland begins to diminish in size and continues to shrink gradually but slowly. During childhood the thymus remains a gland of some size but it meets with misfortune about the age of thirteen or fourteen. At that age it begins a rapid career of degeneration, and although it does not disappear entirely it is represented in an adult by an insignificant remnant.

The thymus gland is an instance of *absolute* diminution in the bulk of an organ with the passing of the years. But during the body's evolution toward maturity instances occur of *relative* diminution in size, and of that phenomenon the liver is perhaps the most interesting example. The liver of a full grown person generally weighs about three pounds and as a rule an adult weighs about forty times the weight of his liver. But the liver of a newly born baby is *relatively* a bulkier organ. So large is the liver of an infant compared with its tiny body that one may safely say its whole body-weight is seldom more than twenty times that of its liver. This disproportion is still more remarkable when we bear in mind that a baby is normally fatter than a man. A baby is, in fact, a very corpulent person; and if we remained as obese throughout our lives as most of us are when we set out on our careers we should indeed have fat men about us if not such as sleep o' nights. The plumpness of a baby is not without meaning. It recalls the far away epoch in the history of our race when the vicissitudes of early life were even greater than they are to day and only that sort of baby that came into the world with a good reserve of fat would be proof against the troubles that beset the first years of life. Where babies are born into a community that rejoices in a profuse supply of patent foods an abundance of fat is not of such paramount importance, but from an æsthetic point of view the chubby baby will continue to command our admiration.

In any case it is certain that our ideas regarding the correct proportions of the human body will always place upon our babies the duty of hastening to increase the length of their legs. It is known to the privileged who have beheld a newly born child *en déshabillé* that the little legs are very short in proportion to the length of the trunk, but probably the very observant are the only ones who know that a baby's legs measure but one-quarter of its length whereas a man that has grown to maturity owes one half of his height to the length of his legs. But even in the interval that elapses between birth and the first attempts to walk, a baby will reduce this disproportion to a very considerable extent. Indeed, a rapid growth of the lower limbs is a feature of early life, and a child of three is already half as tall as it is ever likely to be.

During the years of childhood boys and girls increase their heights at the rate of two inches each year, but this rate of increase is subject to variations according to the season of the year and to many other conditions. The greatest variation of this rate of increase occurs at fixed and definite periods for each sex. In the case of girls the eleventh year is generally a year of sprouting, and a little more than two inches is usually added to the height. This annual rate of increase may be continued until the fourteenth year, and from that year to the seventeenth the annual increase is comparatively little. It is very seldom that a girl adds anything to her height after the seventeenth year. With boys the sprouting period is generally postponed until the fourteenth year, and it lasts with them until the seventeenth year During these three years two and a half inches are often added to the height each year but after the seventeenth year the annual increase is seldom more than a quarter of an inch. The twentieth year or the twenty first is, as a rule the last of the years in which youths may add to their height Although the dates of these changes are remarkably universal these measurments and also the ages that have just been mentioned are of course subject to slight variations in different individuals, and this remark will apply to any "dates that may be mentioned in the following paragraphs

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* Chambers's Journal.

In the remarkable growth of a child s lower limbs the thigh is the segment that grows most rapidly but in the case of the upper limbs it is the forearm that is most active in growth From an æsthetic point of view this needs must be so for the hand of a newly born baby is generally a little longer than its forearm But then babies feet and hands are always disproportionately large If a man s feet were as long as the upper part of his arm we should count him a man of very large feet. Yet careful measurement reveals the fact that the feet of most newly born babies are just about as long as their upper arms If a mature man wishes to realize the changes that have taken place in his proportions since babyhood he may contemplate his shapely figure and safely say that his legs are five times as long as they were to start with but his hands are only three times the length of his baby hands

All increase in the bony framework is brought about by a process that is somewhat involved The process is one in which bone gradually takes the place of gristle and this conversion of gristle into bone goes on very generally throughout the skeleton But an exception exists in the case of the bones that form the skull and most of the bones of the face The skull bones and many of the face bones are not formed from gristle but from fibrous membranes So it comes about that when a baby is born its cranium is not formed entirely of bone There are six distinct islands of membrane on the head of a newly born child and it is only in the second year of life that bone replaces these areas of membrane The largest boneless area can be felt on the top of any tiny head that is less than a year or eighteen months old and frequently a line can be felt running straight down the forehead where the two portions of bone have not yet fused into one, a line that is sometimes palpable throughout the whole of life

There are few structures in which the adult differs from the infant more than in the skull It is obvious to everybody that the skull of a baby is exceedingly large in proportion to the size of its face But the differences between the immature skull and the skull of a fully grown man are far too numerous and too intricate to deal with here in detail

It is however worth while to mention one or two characteristic differences between the skull of an adult and that of a child One sometimes speaks of the forehead and the brow as though the words were synonymous General usage knows no difference between the forehead and the brow But probably the English word brow was originally applied only to the prominent ridge over the eyes The Miltonic Satan who with contemptuous brow addresses the Angel Gabriel makes us think not of a wrinkled forehead but of the elevated eyebrows that produce a look of contempt At least to the anatomist there is a difference between that part of the skull which lies just over the eyes and the rest of the forehead In many well developed men it can be observed that the part of the forehead immediately over the eyes is characterized by a distinct slope for about half an inch This obliquity is caused by the formation of air cavities in the bone These cavities are less developed in women than in men and the absence of this slope gives the foreheads of women a nobler' aspect than those of men But we are not born with these cavities in our skulls A child does not show them until it has entered its second year and during childhood they develop but slowly About the fifteenth year they increase more rapidly and they continue to enlarge for many years so that in advanced life they are sometimes of considerable size Air cavities are formed also in a bony prolongation of that hard lump which everybody may feel behind the ear This bony prolongation is taking shape about the fifth year of life and the air cavities make their appearance in it during the eventful fifteenth year

Alterations in the skull naturally suggest questions regarding the growth of the brain The period of life in which the brain adds most to its weight is between birth and seven years of age From seven to fifteen the brain still adds to its weight but at a slower rate than during the previous period From this period of life the brain increases its weight but slowly Still in most cases the brain does not attain its maximum weight until the age of forty After forty the brain loses about one ounce of its weight in the course of every ten years, but this loss of weight is not directly associated with any loss of intellectual strength

The careful reader must have observed how frequently it has been necessary to mention the period of life about the fifteenth year in connection with changes in the body These profound changes are heralding the approach of that period when parentage becomes a possibility It is as though the body hitherto concerned in knitting itself more firmly together were beginning to realize that such a thing as parentage exists and that it is an affair of some importance requiring considerable preparation Only those who are accustomed to think of the human body from a biological point of view can fully realize the amount of preparation it makes for the gallant time of courtship The first inclination to go a wooing generally asserts itself more or less modestly about the age of sixteen When referring to the effect which this event has upon the growth of the body the German biologist Haeckel writes in these terms It is one of the chief mechanical causes of the highest development of life and throughout the whole of nature the greatest effects proceed from this very small cause This period in the life of the developing organism is characterized by the changes of great interest but with the reproving countenance of the editor ever present to one s mind one dare not occupy more space than will be required to explain the breaking of a boy s voice about his fourteenth year The voice as everybody knows is produced by vibrations of the vocal cords The cords extend from before backward inside the larynx The larynx or voice box is composed of several pieces of gristle connected by small muscles The two largest pieces of gristle can be seen in adult men projecting from the throat as Adam s apple It would prolong this article unduly were I to enter in detail into all the changes that take place in the growing larynx while the voice is developing from the high pitched squeak of the infant to the sweet tones of a woman s voice or the deep loud voice of a man I am at present concerned only with the change from the childish treble to the big manly voice and it will suffice if I remind the reader that the pitch of the voice depends upon the length of the vocal cords (the longer the cords are the lower is the pitch) and that the length of the cords depends upon the distance between the back and front of the larynx It can then be easily understood that the pitch of the voice ultimately depends on the growth of the pieces of gristle forming the larynx Now the growth of these pieces of gristle is not uniform throughout life Between the seventh and the fourteenth year the larynx grows but very little About the fourteenth year the pieces of gristle suddenly throw off their torpor and begin to grow with astonishing rapidity So rapid is the growth of a boy s larynx at this period that the unfortunate youth is taken quite unaware Suddenly he finds himself endowed with vocal cords of a length to which he is quite unaccustomed The nerves and muscles that move the pieces of gristle have not yet come to realize what is expected of them under the new conditions and for a while the youth is not quite certain at any given moment whether the sound he is about to bring forth from his larynx will be high or low pitched Meantime the larynx continues its growth and by the time it has become a prominent feature of his anatomy he has learned the trick of this new instrument and begins to speak with a deep and confident voice

It is interesting to consider why this great and sudden increase in the growth of the larynx should affect one sex only To find an answer to this question we must look back to the rude beginnings of human life to the lawless wilderness where our half human ancestors passed their lives We must pictures to ourselves the fierce and ruthless encounters with aggressive enemies that were frequent experiences of the primitive lover and primitive father In such encounters it would be he who possessed a deep strong voice to express his jealousy and rage who would best succeed in driving off the intruder and protecting his offspring Thus his offspring would live to perpetuate the deep voice and by continued inheritance fix it as a male characteristic

There is perhaps no change taking place in the body during its development more reminiscent of our racial history than the phenomenon of teething but here one may give only the briefest sketch of this process When a baby is born there are of course no teeth in the mouth but they are lying beneath the gums embedded in the jaw Some six or seven months later they will begin to appear in the mouth The first to appear are the central teeth of the lower jaw A few months elapse before the central teeth of the upper jaw appear Then there is a rest of a few months and more teeth appear in the lower jaw including the first molar teeth This process of alternate eruption of teeth and resting goes on for eighteen months so that a child of two has a complete set of milk teeth—ten above and ten below This set of teeth serves the child for four years At six or seven years of age a new tooth gradually makes its appearance behind the set of milk teeth This new tooth is the first of the permanent set The milk teeth now begin to drop out one by one as the months and years pass on and when one sees a little boy or girl with a toothless space in the front of the mouth one may guess that the child is about six years old The permanent teeth are constantly making their appearance in the mouth at intervals during the period between the sixth year and the twelfth year By the thirteenth year the permanent set of teeth is practically complete for among civilized races the wisdom teeth hardly serve as teeth however useful they may be to the negro The wisdom teeth may appear any time after the seventeenth year Their advent may be postponed until the thirtieth or fortieth year and sometimes they do not appear at all

It must be clearly understood that I have been endeavoring to give merely an indication of the changes that take place in the body during its development In the course of writing this article I have seen many opportunities for moralizing on physical and mental education but remembering the space at my disposal and the scope of the matter in hand I have refrained from any such references The purpose of my article is served if I have helped my readers to realize that a child becomes a man or a woman by metamorphosis as well as by increase of bulk

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PANAMA CANAL PROGRESS

According to the Canal Record Ancon Canal Zone, April 6th, if the original plan adopted by Congress had been adhered to the excavation for the Panama Canal would have been completed by this time That plan provided for a total excavation of 103,795 000 cubic yards Changes in the plan made subsequently by order of the President, added 70,871,594 cubic yards bringing the total to be excavated up to 174,666 594 cubic yards The estimate of time required for the construction of the canal as originally planned was nine years.

The grand total of excavation accomplished down to the end of March, 1910, is 103,205,666 cubic yards, or within 589,334 cubic yards of the total required for the canal as originally planned As the average daily output exceeds 100,000 cubic yards, the full excavation required by the original plan has since been accomplished

Active excavation work on a large scale did not begin till 1907, and in that year [illegible] cubic yards were removed. In 1908, 37,116,735 cubic yards were removed and in 1909 35 096 166 making the total for the two years 72 212 901 a monthly average for the entire period of over 3 000 000 cubic yards The total excavation of 1904 1905 and 1906 was not quite 7 000 000 cubic yards so that nearly the entire excavation called for under the original plan has been accomplished in three and a quarter years The excavation remaining to be accomplished is the 70 871 594 cubic yards made necessary by the changes in the plan

The grand total of canal excavation in March was 3 067 479 cubic yards 476 750 cubic yards more than the total for February although the rainfall in March was the heaviest since work was begun by the Americans, and at the principal points along the line of the canal exceeded the average for all the years of record The dry excavation amounted to 2 178 618 cubic yards and was principally by steam shovels The dredges removed 888,861 cubic yards in addition to the amount pumped into Gatun Dam by suction dredges.

The record excavation for a single steam shovel working eight hours a day for a month, was made by shovel No 213 which removed 70 [illegible] cubic yards place measurement The highest record for a single day was made by the same shovel 1 823 cubic yards place measurement in a day of eight hours —The Iron Age

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Owing to the climatic conditions in Richmond Va. the wooden panels on the cars are frequently cracked Instead of replacing them with new wood panels the Virginia Railway and Power Company covers the old panels with steel of No 18 gage These steel sheets are screwed on under the old side moldings and when painted they cannot be distinguished from wood In fact there are many cars which have wood panels on one side and steel-covered panels on the other When steel panels are applied they are continued past the belt rail without a break and this prevents the rotting which occurs when water from the belt rail gets inside the car between the joints of the wooden half panels The plates are shaped in the company s shops and are applied whenever it is found that a considerable number of the wooden panels are split.

MEASURING INSTRUMENTS OF LONG AGO.*

THE MECHANICAL APPLICATION OF GEOMETRICAL PRINCIPLES.

BY WILLIAM E STARK

A [illegible] handbook [illegible] sixty years ago [illegible] of

FIG. I.—[illegible] COLLECTION OF OLD MATHEMATICAL INSTRUMENTS MADE BY PUPILS

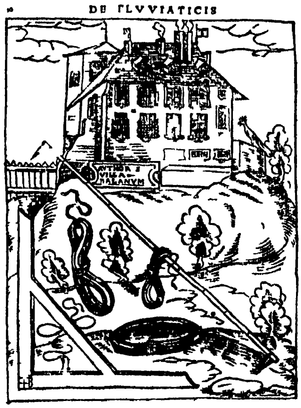

FIG. II.—SURVEYORS TOOLS

Fr[illegible]

several obsolete instruments which furnished excellent illustrations of simple [illegible] principles. Having [illegible] may [illegible] after such profitless digging I [illegible] to follow [illegible] The task has been [illegible] delightful [illegible] [illegible]

are taken from the collection of books and instruments belonging to Prof. David Eugene Smith of Columbia University. Most of the books referred to are of the sixteenth and seventeenth centuries.

The chief advantage of these old instruments for

FIG. III.—USE OF RODS IN LINEAR MEASUREMENT

From La Geometria [illegible] by G. Pomodoro, Rome, [illegible]

FIG. IV.—USE OF SIMPLE SQUARE IN SURVEYING A STREET

From Pomodoro. See Fig. III.

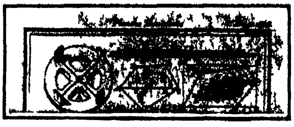

FIG. V.—SURVEYORS CROSS

From [illegible] Traité de la construction et des principaux Usages des Instruments de Mathématique, La Haye, [illegible]

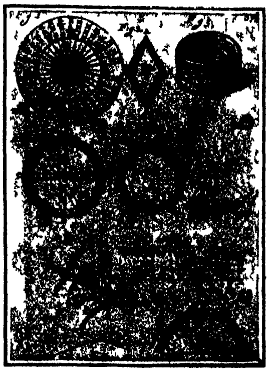

FIG. VI.—NAVIGATION INSTRUMENTS.

From Bion. See note under Fig. V.

educational purposes lies in their simplicity. Modern science demands such a high degree of precision that most measuring instruments of to-day are too complex to be easily understood by the young student. The devices for increasing the accuracy or extending the field of use of one of these modern instruments obscure its fundamental principle. The engineer's transit is many instruments in one.

The primitive instruments were intended for a single purpose and were based on a single principle. To be sure there are in the books referred to many examples of the tendency to combine instruments and many an author undertakes to show how his inven

FIG. VII.—EARLY FORM OF SURVEYORS COMPASS

De Quadrante [illegible] by Cornelius de Judaeis, Nuremberg, 1594

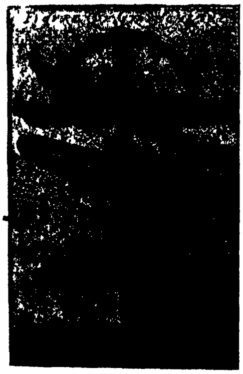

FIG. VIII.—INSTRUMENT FOR MEASURING ANGLES

From Declaration de l'Usage du Graphometre by Philippe Danfrie, Paris, 1597

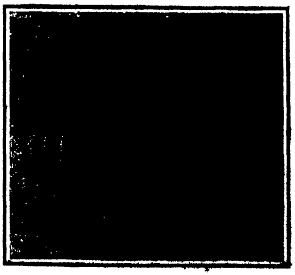

FIG. IX.—OCTANT FOR MEASURING ANGLES AND ESTIMATING DISTANCES BY PROPORTION

From De Octante by R. Hofmann, Jena, 1612.

tion may be used to do the work of all others. Nevertheless the simplest devices will be readily grasped by the youngest high-school pupils, and all that I refer to will be understood by the older students.

The chief value of this material is, I think, for giving concrete illustrations to the abstract theorems. Even the impractical devices will be of service in stimulating the student to follow the [illegible] thought and to discover the sources of error in his process When an author proposes to determine the distance to a point more than a thousand feet away using a base line five feet long our student of geometry is likely to take some satisfaction in proving the inaccuracy of the method

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* [illegible] Science and Mathematics

Some of the instruments may well be used for field problems and simple surveying A good transit is beyond the reach of most schools but many of the instruments described below can be constructed easily and cheaply by a boy who has had some training in woodworking A few illustrations of instruments made by boys of the Ethical Culture School are shown

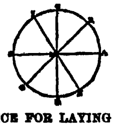

FIG X —DEVICE FOR LAYING OUT PLOTS

These instruments form a nucleus for a little mathematical museum and are used occasionally for field practice If it be suggested that the results obtained by such crude instruments will be too inaccurate to interest pupils in making the measurements it should be remembered that surveyors and military engineers found these same devices accurate enough for all their work for some centuries One who has used only precise instruments will be surprised at the degree of accuracy which it is possible to obtain after practice with such simple tools as those described

INSTRUMENTS FOR MEASURING DISTANCES

The instruments used for making direct measurements of length in the sixteenth and seventeenth centuries were rods of various lengths subdivided into smaller units cords with knots to mark the divisions and chains much like those still in use The most noteworthy characteristic of these linear measures is the variability of the units After reading a few pages of equivalents for use in turning units of land measure of one city into those in use in adjacent places we wonder first why there should be complaint of present conditions and then why when such notable progress has been made it should be so difficult to take the last step

Ottavio Fabri* in his treatise on the squadra mobile gives tables of linear and square measure for twenty-one cities, nearly all of them in Italy He says In Ferrara land is measured by the *moso* which is 66 poles (pertiche) 6 feet and 8 inches long and 20 poles wide In the measures of Ferrara these 66 poles 6 feet and 8 inches are equivalent to 116 poles 4 feet, 8½ inches in the measures of Rovigo and the 20 poles of the width are equivalent to 35 poles and 2½ inches The product of these is 4 091 *tavole* 3 feet 2 inches which is equivalent to 4 *campi* 3 quarters, 101 tavole 3 1/6 feet in the measures of Rovigo The 66 poles 6 feet and 8 inches in Ferrarese measures make 127 poles and 2 inches in Paduan units and the 20 poles of the width make 38 poles 8 inches Paduan The product is 4 841 1/6 tavole which is equivalent to 5 *campi* 3 quarters 11 1/6 *tavole*

INSTRUMENTS FOR MEASURING ANGLES

For laying off right angles a tool like an ordinary carpenter's square was often used Fig IV shows such a square attached to the measuring cord for use in laying out perpendicular offsets Another device for the same purpose was a sort of cross mounted on a staff (see Fig V)

For measuring angles a graduated circle or circular arc was employed In some instruments the angle was read by means of a rule or alidade, pivoted at the center of the arc; in others a plumb line hanging across the scale indicated the angle, while in still others the reading was taken at the point of a magnetic needle. An example of each of these types is given in the following illustrations.

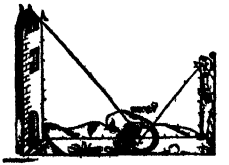

FIG XI.—USE OF MIRROR IN MEASURING A HEIGHT

From De Re et Praxi Geometrica by Orontius Finaeus, Paris, 1556.

In Fig. VI, 4, a simple form of astrolabe a full circle graduated in degrees, carrying an alidade with sights through which the observation is made For measuring the altitude of the sun the astrolabe was supported by the ring at the top the plane of the instrument turned toward the sun and the alidade revolved until a beam of light passed through both sights The edge of the alidade touching the scale then indicated the required angle This instrument mounted on a staff could also be used in a horizontal plane

In Fig VI 6 is shown a quadrant with graduated arc and plumb line hung from the center In the illustration an angular altitude is being measured by aiming one of the bounding radii at the sun The plumb line indicates the angle The principle here exemplified is met by the student of geometry within a few days after the beginning of the course

Fig VII is an engraving of an instrument using a magnetic compass for measuring angles The angle which any line makes with the magnetic meridian is obtained by setting the line of sight which is parallel to the zero diameter of the compass dial—in coincidence with the required line and noting the point on the dial indicated by one end of the needle Of course any angle can be calculated when the bearings (angles with the meridian) of its sides are known This instrument does not differ in principle from the surveyor's compass still in use

In many instruments a semicircular arc was used for measuring angles (Fig VIII) and an author writing in 1612 dilates on the advantage of an octant (Fig IX) In the latter instrument the principle of the diagonal scale was used to subdivide the arc into ten minute intervals

FIG XIII

From Apiaria Universae Philosophiae Mathematicae by M B[illegible]us Bologna 1645

FIG XV —MEASURING DISTANCES FROM A FORTRESS

From Bettinus

A few inventors made use of the principle of measurement of inscribed angles In the ring (Fig VI 5) used in navigation for taking the altitude of the sun a ray of light passed through a small hole *C* and fell on the inner surface of the ring opposite the hole The scale on this inner surface was formed by dividing the semi-circumference of the ring into ninety parts the zero being at the same level as the hole which admitted the ray of light Thus the tiny spot of light falling on the scale indicated the altitude

An interesting device for increasing the accuracy of an instrument without adding greatly to its weight is shown in the English quadrant (Fig VI 9) This consists of a staff *AB* about two feet long to which are attached two arcs *BC* and *DE* as shown in the diagram *DE* is divided into sixty divisions of one degree each *BC* which subtends an angle of thirty degrees can on account of its longer radius, be divided into spaces of five minutes each Each arc carries a movable sight (*F* *G*) and a third sight is placed at *A* the center of both arcs In practice *G* is placed at any convenient division and *F* is moved until the angle *GAF* coincides with the required angle and the sum of the readings on the two arcs is taken In measuring the altitude of the sun *F* is held at the eye, *A* is aimed at the horizon, and *G* is raised or lowered until a ray of light passing through *G* falls at *A*

Mutio Oddi† writing at Milan in 1625 describes an instrument in which fixed sights are placed at convenient angles with each other as shown in diagram in Fig X The diameter *OR* bisects the quadrants (*MA* and *SM*) while *IN* makes an angle of thirty degrees with *OR*. This device was to be used in laying out plots of land in the shape of regular polygons

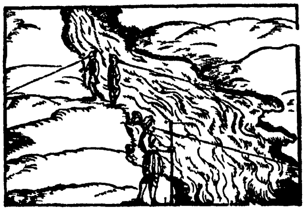

FIG XII —MEASURING WIDTH OF STREAM

From Del Misurar con la Vista by Silvio Belli Venice 1569

The instrument was set either at the center or at a vertex of the proposed polygon which by setting the proper sights the observer could lay out the required angle for many of the polygons When an angle could not be obtained directly from the instrument the nearest angle was laid out and corrected by means of a table of tangents given by the author On reaching the theorem on the sum of the angles of a polygon pupils will be interested in seeing how many of the regular polygons can be constructed by using angles taken from a figure like the one referred to

FIG XIV

From Bettinus See note under Fig XIII

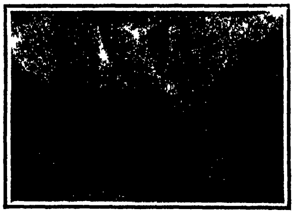

FIG XVI —FINDING DISTANCES ACROSS A VALLEY

From Bettinus

The *radius astronomicus** used by astronomers for taking angular distances consisted of a staff with a cross bar which could be moved along the staff always remaining at right angles to it The staff and cross bar were graduated in small divisions and sights were placed on the cross-bar and at the end of the staff For taking the angular distance between two stars one end of the staff was held at the eye and the cross-bar was moved until the sights placed at equal dis

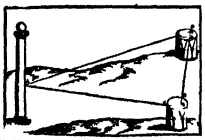

FIG XVII —MEASURING A DISTANCE BY PROPORTION

From Belli See note under Fig XII

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* [illegible] Ottavio Fabri, Venice, 1598.

† Dello Squadro Trattato di Mutio Oddi da Urbino Milan 1625

* Scripta Clarissimi Mathematici M Joannis Regiomontani de Torqueto, Astrolabio Armillari Regula magna Ptolemaica, Baculo Astronomico et Observationibus Cometarum [illegible] necessariis Johannis Schoneri Carolostadii additionibus. Nuremberg 1544.

tances on either side of the staff were in line with the stars Having read the number of divisions on the staff from the eye to the crossbar and the number of divisions between the two sights on the crossbar itself the observer could look up the required angle in a table The radius was provided with crossbars of various lengths the observer selecting the one best adapted to the size of the angle to be measured

A later form of this instrument used in navigation had on each face of the staff a scale corresponding to one of the crossbars from which the angle could be read directly (Fig VI 7)

INSTRUMENTS FOR MEASURING DISTANCES BY PROPORTION

The properties of similar figures are exemplified in many ingenious instruments and an indefinite number of problems I shall mention first a few of the common problems solved without the aid of special instruments and then describe the devices invented for making similar measurements with greater accuracy

Heights of towers and walls widths of streams and moats and distances to inaccessible objects seem to have occupied much of the attention of practical mathematicians Many of the authors refer to the ancient problems of calculating the height of a tower from the length of its shadow or from measurements to a mirror placed on the ground, in which one sees the top of the tower (Fig XI)

A quick but not very accurate method of measuring the width of a stream was to plant a staff vertically on one bank fasten near its top a shorter rod in such a position that it pointed at the opposite bank then rotate the staff until the shorter rod pointed at a spot on the same bank as the staff The required distance was then obtained by measuring from this spot to the foot of the staff In Belli's geometry 1569, this problem is illustrated by an engraving in which the observer himself takes the place of the staff and the visor of his cap the sighting rod (Fig XII) This problem will serve as an illustration of the equality of two triangles having two angles and a side of one respectively equal to the corresponding parts of the other Pupils will be interested in finding out by a drawing how much error will result, if the staff is not quite perpendicular or if the two points sighted at are not quite at the same level

Much ingenuity is shown in devising figures in which the inaccessible distance is equal or bears an easily determined ratio to a line which can be measured directly In the problem shown in Fig XIII the distance of a ship off shore is measured by bisecting the angle formed at the observer's eye by his line of sight to point A on the vessel and to a point C on the shore opposite A. The distance from C to the intersection of the bisector with AC is of course equal to the required distance

In Fig XIV, EC is the required line EB is laid off perpendicular to EC and at any convenient point, as B the angle EBC is measured CE is then extended making ED equal to EB and angle EDA is laid off equal to EBC The distance from E to the point of intersection of DA with BE produced is equal to the distance sought

Fig XV illustrates the measurement of the distance to a fortress from a point beyond the range of the cannon of the garrison EHI and HGI being right angles, the measurement of GH and GI is sufficient for the calculation of the result

Fig XVI shows a method of finding the distance across a valley by measuring a base line CF, and calculating the ratio of the sides of a small triangle similar to the large one of which the required distance is a side Some solve such problems by sighting at the inaccessible object from two ends of a measured base line representing the base line and the directions of the sights by lines on paper and scaling the required distance Belli shows how this may be done when needed in military operations by drawing on a drum head (Fig XVII)

(To be continued.)

"ILO," A THIRD UNIVERSAL LANGUAGE.

AN IMPROVEMENT ON ESPERANTO.

Every person who reads or writes scientific works has no doubt felt the want of a universal scientific language and deplored the loss of time and labor occasioned by the fact that literature and particularly the literature of the exact sciences, is published in many languages

We had once a common scientific language Latin but its decline could not be stopped We all know the reason for this change The development of natural history introducing ideas which could not be expressed adequately in Cicero's tongue the spread of knowledge among large classes of people having no classical education the founding of polytechnic colleges and finally the jealousy of nations which caused their scientists to write in their own languages—all this has worked together to drive out Latin in favor of modern languages

Thus instead of a single scientific language we now have three English German and French But even the knowledge of these three is no longer sufficient Italians the Dutch Russians Poles Czechs Hungarians Scandinavians and Spaniards will frequently use their native tongues in their scientific works many articles thus escape general notice or reach the public only with considerable delay or in mutilated form

Conditions are still worse in oral intercourse especially at scientific congresses Every member of a congress will have noticed that whenever a speaker addresses the meeting in a different language a considerable portion of the audience will leave more or less noisily not wishing to be present at the reading of a paper they cannot understand

A writer in Umschau therefore finds a real demand for a general scientific language Any attempt to adopt one of the modern languages for this purpose would be hopeless since international jealousy alone would wreck it The widely used English language which might be favored on account of its simple grammar would be little suitable in view of its extremely difficult pronunciation Universal acceptance therefore can be expected only in the case of a language built up on possessions common to all those nations for whom the general language is intended Here the objection will be made So you mean an artificial language that is a Utopian plan' How can anybody think of artificially producing a language which is a kind of organism capable of spontaneous development and continued life' You might just as well propose to artificially create a living horse It is true we cannot make a living horse but we can make an automobile capable of taking the horse's place under certain conditions and even surpassing it in efficiency Just as the automobile did not become of practical importance until countless experiments had been made so the idea of an artificial international auxiliary language which today can look back upon an evolution lasting three centuries did not at first, yield any practical results

The first universal language to find actual use was Schleyer's Volapuk This linguistic experiment carried out with admirable thoroughness is indeed very instructive and important and very interesting are the conclusions as to theory and practice of the international language which may be drawn from the growth and the early decline of the Volapük movement Yet this decline showed very clearly that in such things also experience is the only true teacher The fate of Volapük was sealed when its adherents in 1889 ventured the experiment of calling a congress at which Volapük was to be spoken Although a few Volapukists actually succeeded in speaking this language the attempt showed with cruel clearness that the goal could not be reached with this system

Almost simultaneously with the invention of Volapük the Russian physician Dr Zamenhof published his system under the pseudonym of Doktoro Esperanto But as Esperanto appeared just while Volapük was at high tide, it did not create any impression at first. In France it found a zealous champion in the Marquis de Beaufront to whom the Esperanto movement owes its greatness

Zamenhof's contribution is to be highly esteemed since at a time when the question of the best construction of an international language had not even been seriously raised he succeeded in building up one that in many respects surpassed the attempts made previously and in practical use proved a suitable means for international intercourse Still Esperanto needed improvement in various directions The Esperanto characters are partly distinguished by a circumflex which is a drawback in writing and printing Besides the ordinary parts of speech which have their characteristic terminations or suffixes Zamenhof employs a new one invented by him, the limits of this class of words, which comprises some adverbs and prepositions but not all of them are not clear by any means Many words taken from well known languages are mutilated The paucity of roots is so great as to lead to word formations the meaning of which cannot be guessed readily

The Esperanto language thus cannot as yet be considered the solution of the problem The intelligent leaders of the movement are fully aware of this particularly M de Beaufront as a champion of the reform which the inventor Dr Zamenhof himself has approved in very material points The proposed improvements are, however rejected by the so-called fundamentist party, in league with a few large publishing houses who are defending their business interests These companies have a monopoly of the rather important trade in Esperanto publications, by reason of the fact that Esperanto contains no less than six characters specially invented for it, which are not found in any ordinary printing establishment. They have therefore, as it were declared holy and infallible the grammar published by Zamenhof under the name of "Fundamento de Esperanto" and the reader and the dictionary issued in connection therewith and even go so far as to venerate as "correct' and classical Esperanto the infractions of Dr Zamenhof's own rules some rather bad errors of grammar, and even the misprints found in said books

Under the circumstances no progress can be expected from Esperanto and it is therefore encouraging to hear that a plan has just been published for the creation of a world language based on Esperanto but avoiding its defects This plan is the result of many years' work by an association of the most competent linguistic scholars, the "Délégation pour l'adoption d'une langue auxiliaire internationale," formed in connection with the International Exposition held in Paris 1900

The international character of the language proposed by the delegation is shown best by the following statistics compiled by Couturat He counted the roots employed in the first dictionary of the new language (a total of 5379) and found the following numbers among the words of present day languages

French, 4 880, that is, 91 per cent
Italian 4 454, that is, 83 per cent
Spanish, 4 237, that is, 79 per cent
English 4 319, that is, 79 per cent
German 3 302, that is 61 per cent
Russian 2 821 that is 52 per cent

The grammar of the new language complies absolutely with the chief requirement of an international language system perfect regularity In this new language there are rules which may be printed on one page easily, and no exceptions If you know the conjugation of one verb, you know that of all others, and so on

The result is a language which may be mastered readily by anybody and which has this advantage over other artificial languages that it is based on rational scientific technical principles and therefore is not exposed to the danger of being supplanted by the creation of a still better and materially different language Of course details may be improved here and there but the foundation seems secure and the common auxiliary language of men cannot assume an appearance differing very much from the newly-created Internaciona linguo or by its contracted name Interlingo or still shorter, using chiefly the initials Ilo

Whoever wishes to learn more about the nature of Ilo will find information in the interesting pamphlet World Language and Science," published at Jena 1909 by Gustav Fischer and written by five well known professors and committee members of the delegation L Couturat of Paris, O Jespersen of Copenhagen R Lorenz of Zurich W Ostwald of Gross-Bothen and L Pfaundler of Graz.

A specimen will show better than long explanations that the new world language is not an unpronounceable, artificial production, but a euphonious language which lends itself to easy and fluent treatment

Literal English translation from the German original of a passage from Gompers, Griechische Denker 2nd volume, 2nd edition, page 86 Leipsic 1903	L Couturat's translation from the German original into Linguo Internaciona di la Delegitaro (Ilo)
Socrates Life and Activity.	Vivo ed Agado di Sokrates
Clear, cool heads of considerable strength have existed in all centuries, and also of warm hearts there did not often reign a sensible want. But a warm heart beneath a cool head, that is a rare combination and the rarest of all phenomena is a heart working with unusual might which uses its whole impulsive power to keep the head cool—comparable to a steam boiler which operates an ice plant. Scarcely once in thousands of years will such a combination on a grand scale recur.	Klara, malvarma kapi di suficanta forteso existis en omna yarcenti ed anke de varma kordyi ne ofte regnis sentebla manko Sed varma kordyo sub malvarma kapo to esas rara uniono, e la max rara de omni fenomeni esas kordyo laboranta per extraordinara forteso, qua uzas sa tuta impulsovo a konservar malvarma la kapo—komparebla a vapor—kaldrono, qua funcionigas glacyofabrikeio. Apene un foyo en yarmili revenas tala uniono en granda mesuro.

THE PROPHECY OF FRANCIS BACON, 1560-1910.*

A PIONEER IN NEW FIELDS OF INTELLECTUAL ENTERPRISE.

BY PROF. RALPH BARTON PERRY, HARVARD UNIVERSITY.

I *Bacon and the Spirit of Discovery*—There are several ways in which the importance of a philosopher may be estimated He may be regarded as an exponent of his times, that is as a representation in which the manifold tendencies of an age are focalized and idealized Or he may be regarded as the author of a panorama of existence of a world view or system which while it may be superseded will always retain enough of logical and imaginative coherence to make it typical and classic Or the philosopher like other servants of mankind may be judged according to the degree in which he has been confirmed by posterity Judged by this last standard the great philosopher will be the philosopher who while he may like Bacon have been born three hundred and fifty years ago is nevertheless modern in the sense that he is identified with important ideas which are now generally held to be true This brief summary aims to present the Bacon that is living to-day in our common opinion in our expert knowledge and in our dominant ideals

Any one who considers Bacon in relation to European civilization of the modern period must be impressed with the degree to which he represents its progressive ideas Those characteristics of the sixteenth and seventeenth centuries which are most marked in Bacon are the characteristics in which they anticipate later centuries It is possible for our immediate purposes to reduce these characteristics to one The disposition namely to look for a betterment of human life from the advancement of knowledge Advancement of knowledge does not here mean the education of the individual but the winning of new truths by the race and for the good of the race We may call his the spirit of discovery where discovery is used both in the theoretical and in the practical sense Bacon himself was not a discoverer of new scientific truths but the discoverer of the art of discovery As he expressed it he rang the bell that called the other wits together While it is doubtless inaccurate to attribute so general an idea to any individual authorship Bacon was its greatest prophet His brilliant literary gifts his imagination his sanguine temperament his breadth of view and his native regard for utility the very qualities that helped to unfit him for exact research made him the most important medium through which the idea of discovery or of intellectual conquest has gradually become the hope of mankind

II *The Baconian Reform*—This idea was defined by Bacon largely in opposition to what he believed to be the blindness and errors of his own and earlier times Philosophical literature nowhere else contains so acute and so comprehensive an examination of man s intellectual bad habits Bacon s criticisms may conveniently be brought together under four heads

First he defined the persistent error of *anthropomorphism* It is customary for man to fashion things after himself He is deceived by what Bacon calls the 'idols of the tribe or the prejudices characteristic of human nature in general and by the idols of the den or the prejudices peculiar to the individual But if he is to view nature as it is he must efface himself

Second he found the thought of his own time to suffer peculiarly from *conventionality* It was customary for men to accept what was current and supported by general opinion There are two important means through which arbitrary or ungrounded ideas are foisted upon belief: language which gives rise to what Bacon calls the "idols of the market place' and established *systems* or theories which have the stage, and which give rise to what Bacon calls the idols of the theatre" In the interests of truth it is necessary to guard against the suggestive power of words which are often obscure or even meaningless and against the inertia of doctrines that have acquired repute and prestige

Third it was customary in Bacon's time to a degree that is scarcely intelligible to-day to assent to theories of nature on grounds of *authority*, ecclesiastical or political Bacon is among the first to formulate the principle of tolerance, according to which there is hope of knowledge, provided only that the mind be free from external constraint The truth-seeking mind can acknowledge no obligations except to evidence.

Fourth, Bacon attacked the tendency, common at the time of the Renaissance, to rely on antiquity. The essentially modern character of Bacon's mind is nowhere more apparent than in his repudiation of the idea that dominated the revival of letters He detected the dangerous fallacy which had arisen with the new study of the ancient languages and literatures His torical retrospect inverts the intellectual values of the race The wisdom of the ancients is but the folly of youth—*Antiquitas saeculi juventus mundi* The hope of knowledge lies not in a return to childhood but in a maturity yet to come

III *The Baconian Survey*—As a pioneer in a new intellectual enterprise it fell to Bacon to draw a rude map of the settled domain and border wilderness of knowledge It is impossible here to enter into the merits and demerits of his classification of the sciences Most interesting to us of the present is his explicit provision for what is now known as applied science But there can be no doubt of the service which Bacon rendered in making such a classification at all To Bacon modern science is largely indebted for the sense of solidarity that obtains among all special investigators He was in a measure at least responsible for the organization of the Royal Society in London and of similar societies on the Continent He inspired the collective scientific movement of the Encyclopædists and directly or indirectly the systematization of science made by Comte Spencer and others The present idea then that the several sciences are the members of one body and that those who serve them are serving in one army to achieve the conquest of the unknown is an idea to which Bacon testified clearly and effectually

IV *The Baconian Method*—But Bacon did not merely point out the promised land and exhort men to discovery he organized a plan of campaign There is an opinion to the effect that while Bacon was enlightened in his general ideas he was benighted in his particular ideas This opinion is entirely unjust Bacon does make many of the mistakes current in his time and he deliberately makes many loose statements in hope that they may prove suggestive and stimulating Furthermore he necessarily uses terms such as form which because they were borrowed from Greek and medieval thought suggest to our minds something pre scientific and obsolete But this very term as actually employed by Bacon is the closest approximation in his time to the modern conception of cause as employed in such sciences as molecular physics and chemistry Furthermore and be it said to his great and enduring credit he was the great systematizer and popularizer of experimental method The incompleteness of the Baconian method is the incompleteness of the experimental method Although he did not by any means ignore it it is true that Bacon did not adequately realize the importance of the quantitative or mathematical formulation of scientific laws But this fact in no wise affects the correctness of his statement of the experimental method The Baconian plan of research avoiding technicalities may be said to contain four important ideas all of which have been approved and employed in subsequent scientific procedure

His first and fundamental idea is that of *observation* Bacon never wearies of reminding us that the mind must be brought into direct contact with things In the study of nature we may see he believes by the 'ray direct To avoid verbalism dogmatism or ambiguity it is necessary that the mind should be open to the facts and that it should follow their leading 'We can only conquer nature by first obeying her But Bacon understood the fruitlessness of desultory observation For purposes of explanation all facts are not equally significant

Hence, secondly he was led to define certain methods or *canons of induction* It was Bacon who first called attention to the importance of glaring' or striking' instances in which the phenomenon under investigation is thrown into relief, parallel" instances which permit of the argument from analogy, and 'crucial' instances which serve as tests of contrary hypotheses From Bacon Mill derived the methods to which he gave such prominence in his *Logic* the methods namely of "agreement,' 'difference" and 'concomitant variation" By means of these methods it is possible to single out from among the circumstances attending or preceding the phenomenon to be explained, that which is its probable cause That which is present when the phenomenon is present, which is absent when the phenomenon is absent, and which shows like quantitative changes, may be assumed to be connected with the phenomenon, and to point the way to its explanation.

But, thirdly, it is necessary to supplement observation of the natural course of events with artificial *experiments* Nature like men will reveal her secrets only when put to the torture Bacon was a consistent advocate of the first hand manipulation of natural bodies He saw this to be the only method of study which afforded any prospect of laying bare the more subtle physical phenomena such as heat light and the transmutation of substances The later development of physics and chemistry not only confirmed this judgment but in several signal cases fulfilled definite predictions which Bacon based on it

Fourthly Bacon recommended the *comparative* and *historical* method He was one of the first to appreciate the importance of studying all phenomena that develop in different stages of their development In the particular case of anatomy he called attention to the importance of studying the structure of organs in their simpler forms and using the results as a key to the complex forms

V *The Baconian Pragmatism*—Bacon s extraordinary modernism appears not only in his definition of sound and fruitful methods of scientific study but also in his conception of the relation of science to civilization And in nothing is he so modern as in this He asserted that the hope of man lay in his advancing knowledge and control of nature This idea is undoubtedly a present commonplace but there are few philosophers that anticipate the commonplaces of mankind by three centuries and a half But the idea is too fundamental properly to be called a commonplace It is the most fruitful idea in modern life the main presupposition of progress Bacon sought to promote learning for the sake of power That this is essentially a modern idea will be apparent to any one who will study the motives underlying earlier periods of European civilization The ancient world had its critical and its dogmatic idea of progress The former was that of national or racial aggrandizement the conquest of territory and political control The latter contributed by the genius of Greece was the humanistic idea of the intensive cultivation and refinement of human nature These ancient ideas were superseded by Christian supernaturalism which referred man s hope of salvation to another world which might be won by the repudiation of this As Christian Europe became secularized there developed the theocratic idea of a fixed system in which all human activities should be limited and controlled by religious authority Finally as a reaction against the established order there appeared the idea of the Renaissance an enthusiasm for antiquity and desire to reverse the course of history The modern idea though it borrows something from all of these ideas is fundamentally different It bespeaks a solidarity of mankind in the enterprise of life and in this manifests its christianity and it derives from paganism a respect for human capacities and a confidence in man s power to win the good for himself But these motives are so united in the modern spirit as to produce something genuinely new The good is to be won by the race and for the race it lies in the future and can result only from prolonged and collective endeavor and the power to achieve it lies in the progressive knowledge and *control of nature* This is the Baconian idea The incentive to knowledge lies in its application to life For fruits and inventions are as it were sponsors and sureties for the truth of philosophies Therefore Bacon would have men of learning begin and end their study with the facts of their present environment For our road does not lie on a level but ascends and descends first ascending to axioms then descending to works In the last part of the New Atlantis there is a remarkable description of the riches of Solomon s House the great museum and laboratory the treasure house and workshop which was "the lantern of this kingdom The words with which the father of Solomon s House receives his visitors are a terse and eloquent summary of that which Francis Bacon prophesied and which posterity has steadily achieved The end of our foundation is the knowledge of causes and secret motions of things and the enlarging of the bounds of human empire to the effecting of all things possible '

India rubber under tensile stress contracts strongly when its temperature is raised Work is done by its contraction at the expense of the energy of the heat Hence, according to Prof S P Thompson it would be possible to construct a thermal engine in which the working substance is India rubber instead of steam or hot air, and operating by contraction, instead of expansion, of the working substance

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* Popular Science Monthly.

A PROFILE PUPPET-SHOW.*

HOW IT CAN BE MADE AND USED.

BY A ROZE.

The making of the figures etc in a profile marionette show differs considerably from the regular marionette puppet show the latter consisting of well-constructed dolls carefully made and full of mechanism dressed in silk and satin costumes all of which occupy a long and arduous time in the making Here the author has worked out a marionette show which should cost but little money and much time need not be spent in its completion When finished it will not only be an entertainment for the drawing room but is equally suitable for the garden under the shadow of some leafy tree and when well manipulated (a pretty easy matter with profile figures) a most enjoyable and mirth provoking show When in the garden place the stand so that the sun does not shine on the proscenium front and platform

The drawings illustrating this article are made so clear that the young mechanic and showman will find no difficulty in proceeding with his work without hesitation The figures must be made of cardboard colored and tinseled the construction of which will be given later on First we will make the show or fit up Fig 1 shows the proscenium front with the curtain up and ready for the performance to commence The curtained front here seen should be made all in one piece suspended from the top by a bamboo pole The reason for its being in one piece is portability in setting up and packing away The opening showing the scene may be of any measurement desired according to the size and proportions of the figures but a 2 foot 6 inch opening will be found in most cases sufficiently large and the height in center where the ball fringe is seen 1 foot 8 inches the curtain on either side about 18 inches in width The depth of curtain from the platform to floor must be determined by the height of the chairs upon which the structure rests the same applies to the curtain above the proscenium opening The depth must be calculated by the height of the marionette manipulator who must be completely shielded when standing on a chair or a box working the figures over the top of scenery

The platform or stage may be painted a medium toned green or covered with green baize—the latter for preference The scene may be painted in water-colors on stout cartridge paper in distemper on calico or oil painted on American cloth—this being the strongest A scene should be drawn and painted similar to the one shown with floral arches etc the sky or where the sky should be to be painted a dead black this and the general design tending to hide threads which support the puppets The curtain by preference should be made of some dark material—an inexpensive stuff such as can be purchased at most linendrapers shops—say a cheap cretonne The curtain must be made with a hem along the top to admit of a small bamboo rod being passed through *A* (see Fig 2)

The fit up must now be constructed The platform is a single plank of deal ½ inch thick 9 inches in width and 4 feet in length The proscenium opening being 2 feet 6 inches it will be found that about 9 inches extend at either end as shown at *B* This is useful to stand the candles on which are to illuminate the stage also to fix the uprights *C* on that support the drapery the curtain *D* and also the scene *E* The uprights *C* will be found strong enough if made from deal battens 1½ inches square

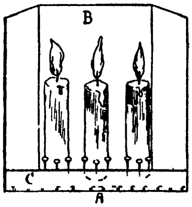

FIG 3—METHOD OF ARTIFICIAL ILLUMINATION

Four uprights or posts are required—two for the front and two for supporting the scene *E* The height of the posts for curtains must be determined by the height of curtain as already suggested The posts are kept in their places by screwing on to each piece an iron angle piece *F* and then held firmly in their places by being tightly fixed on to the platform with a stout thumbscrew Thus the whole can be put together and easily taken to pieces for portability and packed into a small space Should the posts be found not sufficiently rigid with one angle-iron, use two—one on each side On the top of each post, drive in a long screw with a small head These support the curtain pole the latter having holes drilled through it or burnt with a hot iron rod The same proceeding serves for the roller which is fixed to the top of the scene

The lower part of the scene must have an ordinary blind lath glued or tacked on to it so that it hangs flat and taut It will be seen in the illustration that the blind is on a roller which has a metal pin of sufficient length at each end which is held in its place as shown at *G* A single cord running round the roller allows it to be raised or lowered for the performance When the curtain is raised a blind lath is to be attached to the lower part of the blind which will make it hang level and flat on the platform when it descends The cord is tied on a hook fixed into platform at *H* The fit up if properly made will be found so light and manageable that the whole structure can rest upon two chairs as shown A double cord *X* secured by a flat headed nail and tied to the legs of the chairs will make all secure and firm A third chair for the manipulator to stand upon when working the figures is placed in the center Of course chairs need not to be used as boxes of a suitable height will serve equally well but chairs are here suggested as giving about the right height so that the view of the spectators whether sitting or standing shall have the right point of sight

In the event of a garden party performance a couple of wooden stakes driven into the ground for the cord *X* to be fastened to will make it more secure in case there may be a slight breeze No artificial light will be required for the garden performance unless it takes place at night As an illuminant for the show at night three candles at each side of the proscenium, as seen in Fig 2 will be found sufficient Cut a piece of wood about 1 inch thick (see Fig 3) 6 inches wide in front at *A* and 4½ inches at the back the sides to be 2½ inches Then twelve small French nails should be carefully driven into the above wooden base—four for the reception of each candle Next procure a piece of tin about 7 inches in height and bend it as *B* This must fit around the back and sides and be held in its place by the aid of stout tin tacks Next cut a strip of tin 1½ inches wide and secure it along the front at *A* and around the sides as shown by the dotted lines with tacks Then the illumination is ready It must here be observed that the object of the narrow slip of tin is to prevent any overflow of grease on to the platform.

(To be continued.)

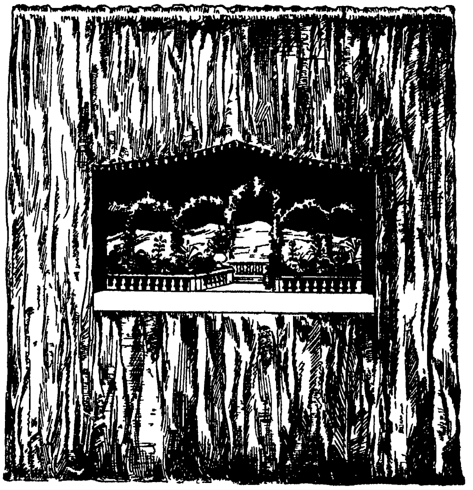
FIG 1—A PROFILE PUPPET SHOW

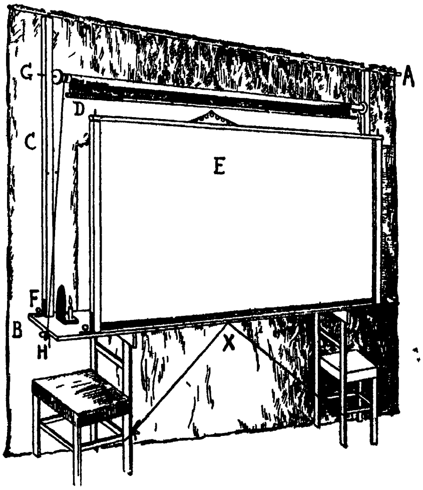

FIG 2—CONSTRUCTION OF PUPPET-SHOW SET UP

Leon Guillet's and Ch. Griffith's experiments on the cementation of iron by pure carbon show there is no cementation if precautions are taken to prevent the presence of gases, but it takes place if contact is insured. Moreover, it increases with the pressure, but always occurs extremely slowly.

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* English Mechanic and World of Science

NEW ELECTRICAL AND PHYSICAL APPARATUS.*

INGENIOUS APPLICATIONS OF NEW AND OLD PRINCIPLES.

A NEW ROENTGEN TUBE OF INTENSE ACTION

A FORM of Roentgen tube which exerts an unusually intense action has been invented by Seitz. In all Roentgen tubes (Fig 1) the cathode rays which are discharged by the cathode with very great velocity impinge upon a metal plate called the anticathode, where they cause molecular shocks which give rise to the short and irregular pulsations in the ether which constitute the Roentgen or X rays In the ordinary Roentgen tube the anticathode which emits these rays is entirely inside the glass tube and consequently as their intensity diminishes in proportion to the inverse square of the distance from the source the strongest part of their field of action is inaccessible In Seitz s apparatus (Fig 2) the anticathode forms part of the wall of the tube and is not inclosed in glass and the rays employed are those which pass through the anticathode and are emitted by its external surface Hence in order to give the anticathode great permeability combined with great radiating power it is composed of three layers of different metals aluminium on the inside copper in the middle and platinum on the outside It is kept cool by contact with an annular vessel of water to which radiating plates of lead are attached The apparatus is designed less for penetration than for the concentration of very intense radiation on a small area

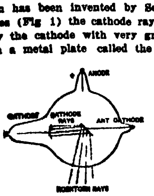


Fig 1 —Ordinary Roentgen Tube.

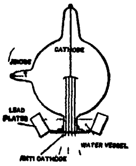


Fig 2 —Seitz's Roentgen Tube.

A NEW ELECTRIC CURRENT METER.

When a solution of a salt of silver is decomposed by an electric current the quantity of silver deposited on the cathode (Fig 1) is proportional to the strength of the current and the duration of its flow The same law applies to the electrolysis of solutions of other metals the quantity of metal deposited by a given current in a given time being the same for all salts of the same metal but different for different metals For example a current of 1 ampere deposits each second 0 001 118 gramme (about 1/60 grain) of silver or 0 000 328 gramme (about 1/200 grain) of copper

Numerous instruments based on this principle have been devised for the measurement of the amount of current or of electric energy furnished to consumers The Stia current meter made by the Schott company of Jena Germany is one of this class which lays especial claim to reliability and certainty of operation. The electrolytic cell (Fig 2) is a closed glass vessel of peculiar form which is divided into a large upper and a small lower compartment by a cylindrical diaphragm composed of glass rods which rests upon a conical elevation of the wall of the vessel The lower compartment and the upper part of the upper compartment communicate freely through the interior of the hollow cone and cylinder, and both are filled with a solution of iodide of mercury The annular space at the bottom of the upper compartment, surrounding the glass cone and cylinder, is kept filled to a constant level with mercury, after the manner of a siphon ink well, by its communication with a lateral reservoir of mercury The mercury and the solution of iodide of mercury are in contact through the interstices between the glass rods but capillary action prevents the mercury from flowing between the rods and down into the lower compartment The mercury serves as the anode of the electrolytic cell The cathode is a thin plate of iridium which is suspended in the iodide solution in the lower compartment While the current flows mercury is deposited at the cathode and an equal quantity of mercury is dissolved from the anode The mercury separated at the cathode flows down into the narrow graduated tube below The level of the mercury in this tube therefore indicates the total quantity of electricity that has passed through the meter When this tube becomes filled the number of ampere hours which corresponds to its total capacity is recorded and the apparatus is made ready for further use by the simple process of tipping it in such a manner that all the mercury flows into the lateral reservoir

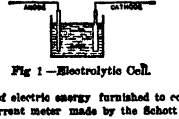


Fig 1 —Electrolytic Cell.

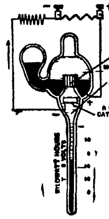


Fig 2 —The Stia Current Meter (Vertical Section of Cell and Diagram of Connections)

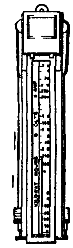


Fig 3 —External Appearance of Meter for House Service.

In order to avoid the necessity of repeating this operation at short intervals the meter is connected not with the main circuit but with a shunt of such resistance that only a small and definite proportion of the current flows through the meter In order to keep this proportion constant and independent of variations in the temperature and consequently in the resistance of the electrolytic cell the shunt resistance is composed of substances which have an aggregate temperature coefficient of resistance equal to that of the electrolyte

In external appearance the small Stia meter designed for use in private houses closely resembles an ordinary thermometer as the small graduated tube is the only visible part of the apparatus (Fig 3) This meter like all of its class can be used only for direct and not for alternating currents

A NEW ELECTROSCOPE WITH QUARTZ FIBERS AND MICROSCOPIC READING

Very great improvements in the construction of electrometers have been made in the last few years One of the new instruments is Wulff s electrometer in which the mutual repulsion and displacement of two parallel fibers of quartz rendered conductive by a coating of platinum are observed by a microscope In the very practical instrument of Lutz Edelmann the repulsion is exerted between a single quartz fiber and one or two fixed metal rods

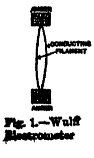


Fig. 1.—Wulff Electrometer

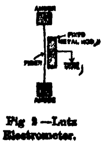
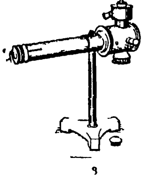


Fig 2 —Lutz Electrometer.

The newest electrometer the invention of Prof Wiechert shows a very notable improvement in the method of reading The electrical part of the apparatus consists essentially of two platinized quartz fibers which are attached by one end to the top of a metal post having an insulating base of amber The fibers when not electrified point obliquely downward and rest against the inclined sides of the support but upon being electrified they spread apart and turn upward The displacements of both fibers are observed simultaneously by means of an ingenious optical device Before each of the fibers is a lens and a reflecting prism so contrived that the images of the two fibers are brought together In this position the images intersect and the point of intersection is read by means of a vertical scale and a single eye lens According to the size and stiffness of the fibers the range of the instrument may be varied from fifty to four hundred volts for one hundred scale divisions The electrostatic capacity is 6 8 centimeters



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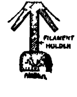

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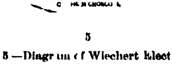
Fig 3 —Wiechert Electrometer Fig 4 —Arrangement of Fibers in Wiechert Electrometer



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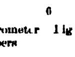

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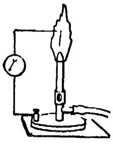
Fig 5 —Diagram of Wiechert Electrometer Fig 6 —Crossed Images of Fibers

ELECTRICITY OF FLAMES

Chiarini has discovered that if the base of a Bunsen burner is connected by a platinum wire with the hottest part of the flame an electric current of about 2 millionths of an ampere flows through the wire the ends of which show a difference of potential of fully 1 volt The circuit formed by the burner the flame and the platinum wire exhibits unipolar conductivity or allows the current to pass in one direction only This circuit may consequently be employed as an electric valve or rectifier for alternating currents



Electricity of Flames

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Some idea of the general use of false teeth may be gathered from the statement that 20 000 000 of them are exported from America to England every year When we consider that probably not more than half the inhabitants of Great Britain indulge in the luxury of false teeth no matter how many grinders they may have lost these figures would seem to indicate that nearly everyone in England suffers from defective or missing teeth As far as observation goes the United States is no better off than England in this respect.

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* Electrician.

THE MICROSCOPE AND THE SCIENTIST.*

SOME APPLICATIONS OF MICROSCOPY TO MODERN SCIENCE.

The time is past when a man can expect to make any real contribution to knowledge by spreading his observations over the whole vast range of microscopic objects. In these days in which the output of research on every subject is enormous and is increasing rather than diminishing a man is more likely to make progress and do useful work by taking up a special line and sticking to it. Speaking for those who work *with* rather than *at* the microscope I would advise everyone who wishes his work to be fruitful in results to have a hobby of his own. In making the suggestion I do not mean that we are all to become narrow specialists interested in nothing but our own particular subject. Specialization in work and in research does not necessarily mean specialization in knowledge or in interests. The great value of such a club as ours is that by bringing together people occupied in different branches of work it enables one man to know what another man is achieving in a different line thereby at once widening his outlook and stimulating him in his own work by producing a healthy spirit of emulation.

My advice therefore to the microscopist would be that he should aim at wide knowledge and diffuse interests but should concentrate his activities and focus his attention on his own particular pet hobby so that by mastering a branch of natural knowledge he may find himself in a position to advance it. However limited the field of study may be however insignificant the objects may appear yet something can always be found which on the one hand will illustrate some important and fundamental principle or on the other hand will prove ultimately to have some direct or indirect bearing on human life and its needs. Let me give two instances in support of this statement. To the so-called practical man it may seem a very trivial occupation to worry about such things as Foraminifera however beautiful their shells may be. Yet these tiny creatures living in a sphere apparently so remote from our own furnish wonderful illustrations of the powers and activities of primitive living matter and Mr Earland has recently directed our attention to the remarkable property they exhibit of selecting particular materials for building up their houses. This is a most interesting fact well worthy of further study especially by experimental methods for it indicates that the most primitive and formless living matter possesses faculties of a kind which we term in higher forms of life instinct or intelligence. Again a reputation for being an expert on let us say fleas may provoke a smile from the uninstructed but in view of the proved connection between fleas and human disease especially plague these paltry insects have now assumed very great importance as objects of study and we find detailed descriptions of them in the reports of government commissions. As Lord Crewe remarked in a recent speech we commonly speak of any very trivial annoyance as a flea-bite but we know now that in certain circumstances a flea-bite may cost a man his life. Small wonder then that fleas have become important objects of study to mankind.

This question of fleas and plague reminds me that I am here not to preach a sermon but to give an address by recalling to my mind the subject which I propose to discuss to-night namely some of the remarkable advances that have been made during the last few years in our knowledge of human diseases caused by microscopic parasites. This is a subject which has now grown to such vast proportions that I must confine myself of necessity to a small part of it namely the diseases caused by Protozoa. As examples I shall deal more especially with malaria sleeping sickness and yellow fever.

Malaria is a disease which was well known to the ancients and is still very rife in many parts of Europe. It appears to have been prevalent formerly in the fen districts of England but to have died out there from some unexplained reason. It is estimated by Prof Ronald Ross to cause from a quarter to half the total disease in the tropics. It occurs under at least three forms known commonly as tertian quartan and pernicious malaria each of them easily distinguishable clinically and due to distinct species of the parasite differing from one another in morphological characters but similar in the general features of their life-cycle.

Until comparatively recent times nothing whatever was known of the nature of malaria or the manner in which it was acquired. It was generally believed that it was due to a poisonous miasma which arose from swamps and marshes a notion conveyed in the name malaria bad air. This miasma theory is very prevalent in literature for instance in such a work as Dickens's Martin Chuzzlewit where the unfortunate settlers in Eden are supposed to contract fever by breathing the exhalations of the swamps.

The scientific study of malaria may be dated from 1880 when the parasite was discovered in the blood of fever patients by Laveran then a military surgeon in Algiers. Laveran examined the blood microscopically and observed the principal phases of the parasite. It was however some years before Laveran's parasite was accepted as the cause of malaria though it ultimately obtained universal recognition. Even then it remained a mystery how the parasite got into the blood and many still held to the miasma theory. It was supposed by some that the parasite passed out of the body and produced cysts or spores which could be disseminated by the wind just as the cysts of many Infusoria are known to be carried by aerial currents and that by inhaling these air-borne germs the disease was acquired. Others sought for the source of the infection in the contamination of drinking water.

It remained for a countryman of ours to discover the true method of infection. Prof Ronald Ross then in the Indian Medical Service experimented first with the very similar malarial parasites of birds and found that the infection was taken from one bird to another by mosquitoes of the genus Culex. Similar experiments on human malaria gave at first negative results until it was discovered that the necessary intermediate host of human malaria was a mosquito belonging to quite a different genus Anopheles. These experiments were confirmed by many investigators in all parts of the world and led to results which may be stated in two propositions one positive one negative first premising that by a malarial infection is meant a new infection not a relapse in a person previously infected.

(1) Malaria can be and is conveyed from sick to healthy persons by the agency of mosquitoes.

(2) Malarial infection is not known to take place by any other method.

Experiments further showed as I have mentioned already the very remarkable fact that avian malaria can only be transmitted by culicine mosquitoes and human malaria only by anopheline. If human blood containing the parasite be taken up by a Culex the parasite cannot develop but is digested up along with the blood. The same thing happens to the parasite of avian malaria when taken up by an Anopheles.

Following on these experimental discoveries the development of the parasite was studied microscopically in all countries by a great number of observers among whom we may mention especially Grassi in Italy and Schaudinn in Germany. By their combined labors the complete life-history of the parasite has been worked out in the greatest detail revealing one of the most fascinating chapters in natural history.

(An account was then given of the development of the malarial parasite illustrated by a diagram.)

My second example sleeping sickness is also a disease that has been long known though without attracting until recently so much attention as malaria. It was first observed in the West Indies in negro slaves imported from the west coast of Africa the region in which it appears to be endemic. It was observed that the negroes suffering from it were not infectious and that the disease did not spread to others—a fact easily explained by what is now known about the transmission of sleeping sickness namely that it is effected by flies of the genus Glossina commonly known as tsetse flies, which are confined at the present time to the African continent.

Of recent years this previously obscure disease has forced itself on the public attention by its having spread from its native haunts on the west of Africa and invaded regions previously free from its presence. In our protectorate of Uganda in particular it has caused terrible mortality completely extirpating the natives in some parts and numbering also many Europeans among its victims. I do not propose here to enter into the distressing symptoms of this deadly disease but only to deal with what may be termed its natural history.

Before it is possible to understand clearly the nature of sleeping sickness it is necessary to say a few words about similar diseases in animals. It was well known to all African travelers from the time of Livingstone that domestic animals especially cattle, horses, and dogs were liable in Africa to a peculiar fatal disease known as nagana caused by the bite of blood-sucking flies of the genus Glossina the tsetse-flies of which there are several species abundant in various parts of Africa. It was supposed that the fly produced and injected a virus which caused the disease.

The nature of nagana was first made clear by Sir David Bruce who found that the cause of the disease was the presence in the blood of a minute flagellat or trypanosome since named *Trypanosoma brucii* and that the tsetse-fly did not generate the parasite but was merely the unwitting agent in transmitting it from infected to healthy animals.

When the epidemic of sleeping sickness broke out in Uganda the Royal Society at the request of the government appointed a commission to investigate it and Sir David Bruce was sent out as a member of the commission. A trypanosome was found by Castellani in the cerebro-spinal fluid of sleeping-sickness patients and it was shown by Bruce and his assistants that this trypanosome was the cause of the disease and that it was transmitted from sick to healthy persons by the bite of the local species of tsetse-fly *Glossina palpalis*. It was proved by subsequent researches that the trypanosome causing sleeping sickness was identical with one that had been discovered previously in the blood of negroes in Gambia and named *T. gambiense* by Dutton. In short it was proved that sleeping sickness of man is a trypanosome disease similar to nagana of animals but produced by a different species of trypanosome transmitted by a different species of tsetse-fly and running a somewhat different course. Whereas *Trypanosoma brucii* remains in the blood of its victims until their death *T. gambiense* is found in the blood in the early stages of the disease but spreads probably through the lymphatic channels into the cerebro-spinal fluid and then causes the peculiar nervous symptoms which give the disease its name. The rapid spread of sleeping sickness into regions where it was previously unknown is an indirect consequence of the occupation of the African continent by European Powers. Formerly the native tribes were constantly at war with one another and a negro never traveled any great distance from his own village. Now caravans move in every direction and doubtless in this way the disease has been spread by porters and other natives already infected with the trypanosome coming into regions where tsetse-flies abound and there infecting the flies which in their turn have disseminated the infection among the previously healthy population.

Although it was proved experimentally that the disease is propagated by tsetse-flies the exact method by which this is effected has remained hitherto somewhat mysterious. It was proved that the infection could be conveyed by what may be termed the direct mechanical method that is to say if a fly has sucked recently the blood of an infected person its proboscis may contain living trypanosomes and if it inserts its proboscis immediately or a short time afterward into the skin of a healthy person it may convey the infection simply by means of its contaminated proboscis. Experiments showed that infection in this direct manner only took place up to forty-eight hours after the fly had fed on the infected subject and all attempts to obtain infection with flies at a longer interval than forty-eight hours gave negative results. Experimental evidence was therefore lacking for the existence of a developmental cycle of the parasite in the fly although it was argued by many writers that for various reasons such a cycle must exist. Quite recently however a positive result has been obtained by Prof Kleine director of the German Sleeping Sickness Commission in German East Africa. Experimenting with nagana by feeding a batch of flies first on an infected animal and then on a long succession of healthy animals he has made the most interesting and important discovery that the flies are not infectious at all until some three weeks after their first feed and that then they infect every animal upon which they are fed. This result indicates that the incubation period—that is to say the time occupied by the parasite in its cycle of development in the fly—is far longer than anyone had suspected and that the negative results of former investigators are to be explained by their experiments not having been extended over a sufficiently long period. It must be borne in mind that to those working in tropical Africa it is often difficult or even impossible to obtain a sufficient number of experimental animals for such a protracted series of experiments.

From Prof Kleine's experimental results it is evident that the trypanosome of nagana, and doubtless of sleeping sickness also, does undergo a cycle of development in the tsetse-fly, and the way is now open for the microscopist to push in and to observe what becomes of the parasite in this long period that elapses between its being taken up by the fly and being given out again. We may expect that a fascinating and wonderful history will be made known of the transformations and migrations, the amours and the increase of the trypanosome in the bowels of the unconscious tsetse-fly; and we seem now to be in sight of a solution to the baffling problem of the transmission of diseases caused by trypanosomes

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* From the presidential address delivered to the Quekett Microscopical Club in May, 1909, by Prof E A Minchin.

The third disease I have chosen for my discourse namely yellow fever is one sufficiently well known to everyone, by repute at least There is no need for me to describe at length the dreaded Yellow Jack a malady often fatal, and always excruciatingly painful The connection of this disease with mosquitoes has long been suspected, and has recently been proved conclusively by both the American and French commissions sent out to study the disease The mosquito in this case is neither a Culex nor an Anopheles but one belonging to a distinct genus namely *Stegomyia fasciata*, sometimes called the tiger mosquito It has been proved conclusively that the mosquito does transmit yellow fever and it has also been proved that the disease is not communicated by direct infection or contagion through contaminated clothes or dwellings and here let me direct attention to one great obstacle to conducting experiments in yellow fever—the fact namely that the disease is not communicable to animals but only so far as is known to man Hence experimental studies on the disease could only be performed on men who offered themselves voluntarily for this purpose Such experiments were sometimes negative sometimes positive in their result in the latter case of course the subject of the experiment acquired the disease and in one case at least died of it It would require the pen of a Shakespeare or a Milton to do adequate justice to such devotion on the part of these brave men to the cause of science and humanity

By numerous carefully devised experiments a number of important facts relating to the transmission of yellow fever were elicited It was shown that the unknown cause of the disease is in the blood of the patient only during the first three days of the illness so that only during this period can mosquitoes become infected by sucking the blood of the patient Consequently if the patient be protected from mosquitoes for the first three days he ceases to be a danger to the community as a source from which the infection can spread It was shown, further that the mosquito after acquiring the infection goes through an incubation period of from twelve to fourteen days during which it is not infectious, but after that it is infectious for the rest of its natural life and a further point of interest was added by the French commission namely that an infected mosquito may transmit the infection to its offspring so that a mosquito which has never fed on an infected person may be congenitally infectious

I have chosen the instance of yellow fever to put before you because although we have now such an accurate knowledge gained by experiment of the cause and transmission of the disease no one has succeeded as yet in seeing the parasite itself It is practically certain, for many reasons, that there is some minute parasite at work and there are grounds for suspecting that the parasite is a spirochæte one of those minute actively flexible, thread like organisms of which the affinities are so much in dispute at present and which some authorities class with the Protozoa others with the Bacteria but here we have a case where the microscopist has been baffled and where we get beyond the present limits of the powers of our instrument a fact which should make us appreciate the labors of those who study the microscope and strive to perfect it.

Did space permit I might mention many more important discoveries in the field of protozoan parasites causing disease For example, there are the blood parasites of the genus Piroplasma (Babesia) causing fatal forms of hæmaglobinuria in various animals, they are not yet known for certain in man, but a species is known from monkeys, a source which is getting perilously near to us Here the agent of infection is a tick of some sort, and usually the infection goes through two generations of ticks being transmitted from the mother tick, which has acquired the infection, to the numerous progeny of minute six legged tick larvæ, which in their turn infect the vertebrate host. Then there are the relapsing fevers caused by spirochætes in the blood, and said to be transmitted in Europe by bed bugs, but in Africa by a species of tick which lives in mud floors. In India and other parts of the tropics we find that the deadly disease known as kala azar, due to a parasite, is transmitted in all probability by bed bugs All these and many others furnish points of great interest, but I must be content with the three examples with which I have dealt in more detail, in order to show you how great a work has been done and is being done in this field As Prof Osler said recently, these discoveries are going to have an enormous influence on the history of the world and of mankind, because they are going to make the tropics habitable by white men We hear or read so often of such-and-such a country being uninhabitable by Europeans on account of its deadly climate, but when we look into the matter we find that it is not the climate at all that is to blame, but that the white races are killed off by diseases caused by some animal parasite with which they are inoculated by the bite of some bloodthirsty arthropod Take Uganda for instance with which I have a slight acquaintance all that the climate does for you there is to give you a sunstroke if you go out in the heat of the day with inadequate headgear and to make it very difficult to keep awake after lunch Some well known European infectious diseases, such as small pox, are also rife there, but on the other hand some of our familiar plagues, such as tuberculosis rheumatic fever and influenza appear to be absent The diseases that are really to be feared are all such as spring from bites of arthropods If you protect yourself from the mosquito you will not get malaria avoid the tsetse fly which is very easily done and you are safe from sleeping sickness do not sleep on mud floors nor pitch your tent on old encampments and relapsing fever will not trouble you keep rats and fleas at a distance and you are safe from plague With a little care and attention to surroundings the European finds his life in the tropics if anything more free from disease than in our temperate but influenza ridden Palæarctic climate

In the foregoing remarks I have directed attention more particularly to the practical results of microscopy wedded to sagacious experiment and have tried to show how fertile in good results this union has been and promises still to be but I would not have you go away with the impression that I advocate such studies solely on account of immediate practical good to be derived from them Far from it I am one of those who hold so-called theoretical and unpractical studies to be of the highest importance and worthy of all support if only for the reason that being unremunerative they often cannot support themselves All history shows us that the knowledge of general principles must precede their application and practice and that what is purely theoretical in one generation becomes thoroughly practical in the next or in a later one There is no need for me to waste your time by multiplying instances of this familiar truth but I will conclude with a few words on the wider applications of microscopy

In the range of the natural sciences two branches of knowledge stand at opposite poles as judged from the standpoint of the objects with which they deal The science of astronomy deals with the infinitely great the science of biology on the other hand with the infinitely small The astronomer with his telescope astounds us with the distant worlds he reveals to us he thinks in millions of miles as ordinary persons deal with feet or yards and he exhibits to us this world on which we live as but an insignificant planet one of many whirling round a star far inferior in magnitude to many of those we see nightly a tiny speck in the vast ocean of space and matter peopled by a race of puny creatures who style themselves the lords of creation although their dominion does not extend over a billionth part of the universe The consciousness of an endless series of worlds said Kant destroys my sense of importance making me only one of the animal creatures which must return its substance again to the planet (that too being no more than a point in space) from whence it came after having been in some unknown way endowed with life for a brief space

Not less astounding but in a totally different way are the revelations of the biologist with his principal instrument of research the microscope With this he discovers continually new worlds invisible to the unassisted eye and reveals infinite complexity in things apparently the most simple We find in the first place our own bodies to be microcosms small worlds that is of such inexhaustible variety and elaboration of detail that to the human mind they are as difficult to comprehend and to realise in their entirety as the macrocosm or great universe itself We find further that each human body itself appearing as a single individual or unit, is in reality made up of many billions of living units or cells each as much a microcosm as the whole body and thus our instrument the microscope, brings us face to face with the greatest mystery in the whole range of the sciences namely, the problem of life and living matter There is apparently, no gap in nature so profound as that which separates the living from the not living The nature of life, its origin and destiny the laws that govern living matter and vital processes of all kinds these are of all problems not merely the most fundamental in science and philosophy but also the most important for our practical knowledge and daily conduct

It would be futile to assert that human science has as yet made any great advance in elucidating the nature of life On the contrary all progress in research only throws into greater relief the difficulty of the problem, the better we become acquainted with it, the more the mystery deepens Nor would it be right to assert that the microscope is the sole instrument of research in this field Our knowledge of the properties and activities of the living substance and of living things advances daily by leaps and bounds through methods of investigation in which the microscope plays no part I have referred to the knowledge that has been gained of the life history of the parasite of yellow fever in spite of the fact that the microscope has failed completely so far to detect the parasite itself But we may safely claim that the greater and most important part of modern biological knowledge could not have been gained without the instrument which it is the object and purpose of our club to study to perfect and to apply and further that to be able to see the objects with our own eyes makes them much more real and true to us than merely to infer their presence and properties from experiments in the dark so to speak Seeing is believing is an English proverb which has its counterpart in all languages We may be satisfied in our minds as to the existence and behavior of the yellow fever parasite but nevertheless its discovery by optical means would be greatly welcomed as an important advance in our knowledge

There is no greater stimulant to the all important study of living things than the feeling of wonder and delight which the first sight under the microscope of objects otherwise invisible produces in even the most uninstructed mind Most of us probably can date our first interest in minute living objects from the time when perhaps in early youth we were given or allowed to use a microscope with which we could gratify without satisfying our curiosity in looking at all kinds of minute objects In such an occupation the appetite comes with eating as the French proverb says and the instrument which was at first a fascinating toy leads us on until one might almost say it masters and enslaves us In this development there is another instance of the parallel between the progress of the individual and the history of the race To the majority of early microscopists the microscope was but a toy an instrument which competed with the magic lantern as an amusement for drawing room séances and only a serious minority made use of it as a means of earnest scientific investigation There are perhaps still microscopists whose chief delight is to thrill their friends especially those of the fair sex by the sight of hairs on a spider's leg, or the elephantine proportions of a cheese-mite If so let us not scoff as some do at the amateur we ought rather to regard him with the same interest that a zoologist looks on an okapi or a lepidosiren as a living representative of a bygone age For the modern microscopist is fearfully in earnest and has but little opportunity for amusement in pursuing a science which taxes not only his brain but his eyes to the utmost There is scarcely any greater physical strain than the long continued investigation carried on with the highest powers of the microscope and in my own experience I have known some who lacked the physical endowment for such work and others who have been obliged to retire from the field Let us then in a pursuit which but too frequently dulls enthusiasm by fatigue and exhaustion in which our native hue of resolution tends to become sicklied o'er by the pale cast of thought rather envy those who retain the freshness of their early delight and strive to cultivate rather than to stifle that feeling of wonder and curiosity which should be the starting point of all philosophical and scientific investigation Two things said Kant fill my mind with ever renewed wonder and awe the more often and the deeper I dwell on them—the starry vault above me and the moral law within me I venture to think that had Kant lived in our days he would have found a third source of wonder in the contemplation of the simplest living things as revealed by the microscope in the combination they present of apparent simplicity with infinite complexity and of extreme minuteness with the most extraordinary powers To me the observation of a minute organism such as amœba under the microscope is in its way as marvelous as the sight of the starry firmament I see a minute formless creature, without definite parts or organs which nevertheless exercises all the functions of life and exhibits the germ of every faculty we possess and thereby proves that its apparent simplicity and formlessness cloak a complexity of organization far transcending our powers of observation and eluding our means of detection What again can be more wonderful to contemplate than the fact that peculiarities in the complex mental endowment and physical structure of a human being can be transmitted from one generation to the next through the medium of spermatozoon the tiniest cell of the human body in which the microscope reveals only a structure of the simplest kind? These things must rank with the most wonderful and inexplicable of the phenomena that nature presents to us and we are as yet only on the threshold of investigation The stellar universe has been observed its laws and motions studied for many thousands of years but our acquaintance with the beginnings of life and its properties as exhibited by the simplest living things is but an affair of yesterday as it were, and the scientific study of life is as yet in its infancy

In these days of vast and rapid increase of knowledge in such matters there is danger that we may lose the true perspective and that our perception of the whole may be blunted and obscured by the immense mass of detail which forces us to attend only to a small part of our science It is the special function of a club such as ours to keep fresh our enthusiasm and to enlarge our outlook by contact and intercourse with those working in other fields to spread the infection if I may use the term of intelligent curiosity in the minutest natural objects and thereby to attract and enlist new workers in a field in which the harvest is plentiful but the laborers are few

ENGINEERING NOTES

In the south of France there is a concrete arch bridge known as the Pont du Gard which was erected in the year 16 B C The concrete in this was not composed of crushed stone or other small aggregate of the variety now employed in concrete bridge work but was of the old style consisting of alternate layers of large and small stones gravel etc and of cementitious materials Vitruvius describes the materials and methods in use before the Christian era and other writers like Alberti in 1485 and Palladio in 1570 accurately describe the method which the ancients employed of using boards laid on edge and filling the space between with cement and all sorts of small and large stones mingled together It is very improbable that the Pont du Gard would have withstood the rigors of a severe climate but its actual state of preservation as well as that of many other specimens of ancient concrete work proves that if modern work is honestly executed it lasts a great number of years so that a very small yearly sinking fund per cent is all that is required for properly designed and erected concrete work

Although it is possible to resolve into gas almost any kind of solid fuel in a gas producer it is well known that certain fuels—particularly those high in ash and of a caking character—give a good deal of trouble One of the most serious of these troubles states a contemporary is that the fuel welds itself into a large mass which partially chokes the fire in some places and causes passages or holes to be burnt at others Hence poking of the fire is necessary and the poorer the fuel the more the poking In order to reduce this poking to a minimum some producer makers fit shaking or revolving grates The latest design of this character is due to Mr Chapman an American and it is a considerable extension of the principle The lower portion of the producer is divided into two or three rings which are free of each other and rotate at different speeds the joints between them being made by water seals The object is to shake the fuel continuously so that caking or clogging and holes are equally impossible

At a recent meeting of the Transvaal Institute of Mining Engineers Sir Thomas Price made some interesting remarks concerning the relative merits of American and British locomotives The policy of many if not most of the American railways he said was to get the very utmost work out of the engine as soon as it got out on the open lines because they were aware with the constant forward movement of locomotive improvements that the engine which was in the very front rank to-day in a few years became obsolete because of the improvement continually going on Consequently the American practice was to get the very utmost out of the engine and then scrap it That being the case it naturally did not receive the attention and the especial care that was paid to the English engine It was a question whether the American or English practice was the better Their experience in South Africa was that something between those two methods was the better he would not say the mean was the better but the best of the American practice and the best of the English practice was what they found to answer best

A steam boiler and furnace of peculiar construction which requires no chimney because the combustion gases are mixed with the steam which is admitted to the cylinders of the steam engine have been in successful operation for some time on a Russian torpedo boat The apparatus is the invention of a Russian naval engineer named Schmidt Liquid fuel is used, and the combustion gases which have an initial temperature of from 3 300 to 3 600 deg F have a temperature of about 1 800 deg F when they leave the heating surfaces of the boiler The gases then enter a tube into which a fine spray of cold water is injected under pressure The gases are thus cooled to between 6 0 and 900 deg F and the water is converted into superheated or unsaturated steam of the same temperature The mixture of steam and combustion gases is conducted into the upper part of the boiler and flows thence mixed with steam generated in the boiler to the cylinders In addition to dispensing with the chimney the new boiler possesses the merit of very high efficiency utilizing 90 and even as much as 97 per cent of the heat produced by the combustion of the fuel Smokeless combustion which is easily obtained with liquid fuel is essential to the satisfactory operation of the Schmidt boiler

ELECTRICAL NOTES

A correction has been made by R W Gray and W Ramsay in the value given for the half-life period of radium The half life period is 1,744 years, or in other words one gramme of radium will have been reduced to five tenths of a gramme after 1,744 years

According to the Electrical World a State report shows that 26 per cent of the 312 cotton mills of North Carolina are now using electricity as the sole motive power This revolution in the matter of motive power has been achieved practically within the last ten years especially among the new mills while probably 60 per cent of the existing mills have been completed during the ten year period referred to Furthermore it is found by comparison of figures that 35 per cent of the cotton manufacturing plants use electricity either entirely or in part The indications are that this percentage will gradually increase until practically every up to date mill in the South will be electrically driven, unless it is so situated that inaccessibility to electric supply will prevent the change

The prospects of telephony and high speed telegraphy through ocean cables are considered by K W Wagner in Electrotechnische *Zeitschrift.* Hitherto alternating currents have been used for telephony and high speed telegraphy Mr Wagner considers the question mathematically and comes to the conclusion that an alternating source of supply as distinguished from a continuous source is not of itself productive of superior results over a long cable owing to the damping of the current waves and the consequent deformation of the signals No greater distance can be compassed with alternating than with continuous current Wagner looks rather to the employment of Pupin coils or other means of increasing the self induction for the attainment of the end in view

It is stated in the Electrical Engineer that a wireless telegraph detector has been invented by Mr J H A Pike of Arncliffe New South Wales By its use and with wires at a height of 50 feet Mr Pike has been enabled to interpret messages flashed by H M S Powerful from near Auckland New Zealand to the warships lying in Sydney Harbor a distance of 1 350 miles after the latter were unable to keep up communication At various times the inventor has been in communication with shipping at all ports of the Australian capitals excepting Perth and confidently anticipates being able to receive messages over a range of 1 500 miles Messages are recorded telephonically and can be distinctly heard three feet away from the apparatus It is claimed for the invention that it is more sensitive and delicate than any other detector known

C O N C R E T E
REINFORCED CONCRETE and
CONCRETE BUILDING BLOCKS

Scientific American Supplement 1543 contains an article on Concrete by Brysson Cunningham The article clearly describes the proper composition and mixture of concrete and gives results of elaborate tests.

Scientific American Supplement 1538 gives the proportion of gravel and sand to be used in concrete

Scientific American Supplements 1567, 1568, 1569, 1570, and **1571** contain an elaborate discussion by Lieut Henry J Jones of the various systems of reinforcing concrete concrete construction and their applications These articles constitute a splendid text book on the subject of reinforced concrete Nothing better has been published

Scientific American Supplement 997 contains an article by Spencer Newberry in which practical notes on the proper preparation of concrete are given

Scientific American Supplements 1568 and **1569** present a helpful account of the making of concrete blocks by Spencer Newberry

Scientific American Supplement 1534 gives a critical review of the engineering value of reinforced concrete.

Scientific American Supplements 1547 and **1548** give a resume in which the various systems of reinforced concrete construction are discussed and illustrated

Scientific American Supplement 1564 contains an article by Lewis A Hicks, in which the merits and defects of reinforced concrete are analyzed

Scientific American Supplement 1551 contains the principles of reinforced concrete with some practical illustrations by Walter Loring Webb

Scientific American Supplement 1573 contains an article by Louis H Gibson on the principles of success in concrete block manufacture, illustrated

Scientific American Supplement 1574 discusses steel for reinforced concrete.

Scientific American Supplements 1575, 1576, and **1577** contain a paper by Philip L. Wormley, Jr., on cement mortar and concrete, their preparation and use for farm purposes. The paper exhaustively discusses the making of mortar and concrete, depositing of concrete, facing concrete wood forms, concrete sidewalks, details of construction of reinforced concrete posts.

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SCIENCE NOTES.

According to La France Automobile, Marseilles has lately been the scene of certain trials of the "Fabre" hydro-aeroplane, a machine designed to travel either on water or in the air This craft, which is driven by a 50 horse-power Gnome engine has attained a speed of 33 miles per hour as a hydroplane, and in subsequent experiments has risen 6 feet out of the water and continued its onward course in the air for over 500 yards Within the port itself the 'Fabre" has made a flight at a height of 10 feet, and has then been brought gently and quietly to rest on the shore a few feet from the water s edge

A wine which is non alcoholic but which contains all the aromatic constituents of natural wine is made in Germany The manufacture is carried out in three stages In the first stage the temperature of the wine and the degree of vacuum are so regulated that only the highly volatile aromatic constituents are withdrawn while the alcohol is not volatilised The aromatic vapors are conducted through a receiver containing an absorption liquid composed of de-alcoholized wine grape must and sugar The first receiver is then cut off and in the second stage, the heavier aromatic substances together with a portion of the alcohol and water are distilled over The vapors of alcohol and water are condensed in a suitable vessel while the aromatic substances, which are still lighter than the alcohol are conducted onward through a second absorption vessel This vessel is next cut off and the distillation of the alcohol is completed in the ordinary way The contents of the absorption vessels, charged with the bouquet of the wine are then mixed with the residue from the still

A convenient method of refrigeration for analytical and industrial investigations at low temperatures is described by J O Handy in the Journal of Industry, Engineering and Chemistry Mr Handy discusses various methods of refrigeration and gives the preference to the use of carbon dioxide snow with acetone or with petroleum ether Of these, the acetone mixture has some advantages The 'snow is prepared by the usual method of allowing the liquid carbon dioxide to blow off through canvas or flannel bags. The temperatures resulting from various quantities of the snow with 150 grammes of acetone (at 23 deg C) are given as follows 6 grammes of carbon dioxide —5 deg C, 11 grammes, —20 deg C 24 grammes —38 deg C, 45 grammes, —54 deg C, 77 grammes, —61 deg C, excess of carbon dioxide —78 deg C With 114 grammes of petroleum ether of 86 deg B at 22 deg C, the temperatures obtained with different weights of carbon dioxide were as follows 5 grammes of carbon dioxide, 22 deg C, 10 grammes, —36 deg. C, 15 grammes, —55 deg C, 30 grammes, —69 deg C If absolute freedom from risk of fire is desired carbon dioxide and carbon tetrachloride or chloroform can be used for a limited range

W. Fischer has published the results of experiments made for the purpose of separating isomeric chemical compounds by refrigeration When commercial nitrotoluol which contains 38 per cent of paranitrotoluol, 60 per cent of orthonitrotoluol and 2 per cent of meta nitrotoluol is cooled crystals begin to separate at 32 deg F and the quantity of crystals increase as the temperature falls At —0 4 deg F a eutectic mixture is formed and the paranitrotoluol, which melts at 129 deg F can be separated by filtration Nearly all of the para compound can be separated at + 12 deg F, which is the fusing point of orthonitrotoluol A similar method of separation is in commercial use in Germany When a mixture of the three isomeric toluidines is cooled, a solid substance separates at 38 deg. F At — 4 deg F a pasty mass is obtained, composed of crystals of paratoluidine, which melts at 118 deg F, and a saturated solution of paratoluidine in the liquid mixture of the other two isomers. No separation of the xylols is effected by cooling to — 58 deg. F but if the mixture is solidified by means of liquid air and is then reheated, the metaxylol melts at — 53 deg F, the orthoxylol at — 18 deg F., and the paraxylol at + 59 deg. F

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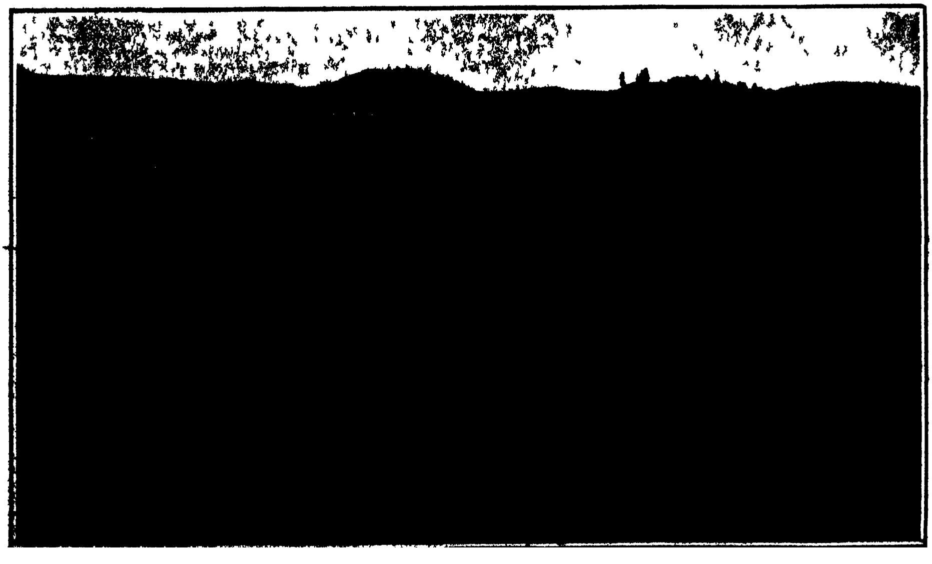

COMPULSORY WORKING OF GERMAN PATENTS.

THINGS THE AMERICAN MANUFACTURER OUGHT TO KNOW.

BY GEORGE NEUMANN.

The present German patent law dates from April 7th 1891 when it took the place of the patent law of May 25th 1877 It enacts in

Section 11 After the expiration of three years reckoned from the day of publication following the grant of the patent according to Section 27 paragraph 1 it shall be revoked

1 If the patentee neglects to put the invention into practice within the realm to an adequate extent or at any rate fails to do all that is necessary to assure this practice

2 If it appears to be required by the public interest that *licenses to use the invention be granted to others* but the patentee declines to grant this permission although upon reasonable compensation and adequate security

Thus the German Patent Act in imposing an obligation of working differs from the original English Statute of Monopolies of 1623 which is the oldest patent law in the world

The idea of compulsory working was embodied however in the French law of 1762 allowing a year in which to begin the exercise this period being lengthened in 1791 to two years of culpable neglect Other countries followed After formation of the German Empire in 1871 there were some doubts as to a patent policy but these were resolved in 1877 by the framing of a governmental bill for an Imperial patent act This regulated the working of the inventions as *set forth in Section 11 already quoted applying therein* the following principle

The revocation of a patent operates first from the moment in which it is canceled It has therefore no reactive (automatic) force

This provision rests on the theory that it is not expedient to facilitate the death of a single granted patent where the general legal requirements have been complied with at the time of its issue A fruitful growth of inventions would thus be impeded through the insecurity of the owner of a patent that it was valid The grounds for annulling a patent are therefore restricted as greatly as possible

This revocation does not take place as the necessary consequence of certain facts designated in the law but may be put into effect where in the presence of such facts the cancelation of the patent is considered necessary by the authorities The possibility of the revocation is therefore a means of warning the patentee that a condition may exist in which it will be necessary

In the current German legislation the revocation of a patent is dependent among other things upon a patentee's neglect to exercise the patent right inside the country within a certain period The rule has not turned out as was hoped but has proved generally inadequate

It is possible to "work" an invention in some simplified manner which does not carry out the spirit of the law to public advantage The government lacks proper means to make reliable determinations on this question of working Such a definition as we have affords no guarantee that the use of the invention is not lost to the country In that respect therefore the plan has failed

Of course the State cannot leave entirely to the judgment of the patentee whether and upon what terms he shall dispose of his patent There is a danger that he will consider only his personal interests and neglect those of the public The risk of a misuse is greater and the evil consequences thereof become the more acute the longer the duration of the patent under the law and the more competition enters from abroad A patent ought not so to be employed that the public productive and competitive conditions become unnaturally distorted Safeguards against misconduct were therefore deemed necessary

Such improper practice can enter in a two fold manner First in this way that the patentee retains the domestic use of the patent exclusively to himself and denies it to others who need it for their business If the invention be of such sort that it materially affects labor conditions the patentee is thereby protected against competition of other manufacturers sometimes even menacing them with ruin and creating for himself a monopoly The improper use of the patent may instead consist in this that the patentee does not put the invention into general use within the country either himself or through another manufacturer but prefers to reserve the patented industry entirely for foreign use in order to supply the inland market with products made abroad In this way also as the invention reacts upon the manufacturing situation the life of domestic industries is jeopardized whereby again the patentee may acquire a virtual monopoly and even a worse one than in the former case to the advantage of the foreign country and to the cost of domestic business Fortunately conditions of trade seldom permit a full carrying out of this assumption Nevertheless even if partially and briefly a force may be at work to distort normal competitive conditions in opposition to public welfare

The provisions in clauses 1 and 2 are therefore intended to counteract a misuse of the patent protection in the two directions here explained Clause 1 is intended to prevent a greater or less domestic monopoly by the patentee Clause 2 is to hinder its use detrimentally to the country in favor of foreign lands Both provisions are inactive during the first three years (the prospectus of the law named two years) for should the patent be unemployed within such time no such great harm could accrue to public interests as to necessitate a revocation before the end of the period

The first provision springs from an assumption that manufacturers will feel a need to use the invention But if after the failure of overtures to that end the offer made to the patentee and by him rejected appears reasonable the authorities are still not obliged to cancel the patent Whether he has so put the country to disadvantage as against foreign lands that grounds for such revocation do exist is difficult legally to determine

SOME DISTINCTIONS ILLUSTRATED IN ACTUAL CASES

The German Patent Office and the Imperial Courts which in the first and second instance are called to consider offers for and revocations of patents have disregarded neither the public good nor the right of the patentee This is illustrated by the following decisions in actual cases

A

In order to prevent the revocation it is sufficient that the subject of invention be brought materially into practice Immaterial deviations from the patent description are not to be considered

The Patent Office refused to cancel patent No 7113 Improvements of rolling mills It said The essence of claim 1 resides in the movable position of a roll which by means of a lever system is pressed against a fixed roll in such manner that the former can be separated from the latter so far as is necessary in order to allow the passage through of hard substances without damage to the rolls In this element of construction which is to be considered essential the roll bench described by Kick and built by Gans & Co agrees with claim 1 To the number of lever transmissions by means of which the mutually pressed rolls are operated importance is attached neither in the patent description nor in the phraseology of claim 1 If, therefore in carrying out claim 1 instead of the complicated lever transmission here provided for a simple one is brought into use this circumstance cannot be maintained against the patentee

Claim 2 protects a construction namely porcelain rolls in roll benches This construction the defendant has not manufactured at home in the quantity required and the period of three years has expired So far as the statutory provisions are concerned this might lead to a revocation The Patent Office has however found in this case no occasion for availing of the authority thus granted to it There has been first the controlling consideration that patent No 7113 presents a unit invention whose component parts for the purpose of their clearer delineation are separately expressed in two patent claims From this point of view, it is sufficient to regard the manufacture as one in order to excuse the failure to put the other part into practice Thus we cannot . require of a patentee from considerations of cheapness especially when he is domiciled abroad that he manufacture the patented invention in all its parts in this country

"The law had an eye . to the progress of German economic interests In the present case however the crucial point of economic significance for home industries in the device protected by claim 2 lies not in its manufacture but in its use It is notorious that the introduction of the W porcelain rolls into the German milling industry has come to pass extraordinarily, and indeed this advantage is so important that in comparison with it the economic benefit which the country might expect from the manufacture of the rolls at home is of relatively little weight

B

If there be worked only one among several varieties of construction set forth in the patent claim or only the invention protected in the supplementary patent, and even if all asserted results do not enter no revocation need be granted

Cancelation of patent No 61 345 automatic fare register was refused on the following ground The Imperial Court entertains no idea that the invention of claim 1 in the form of claims 2 to 4 was worked and worked *to a sufficient extent* This state of affairs affords no occasion to make use of the authority conferred in section 11 clause 1 of the Patent Act to revoke patent claim 1 even partially

C

The Patent Act makes the authority of the cancelation section 11 clause 2 dependent upon public interest The revocation will be denied even among other circumstances when the working of the invention takes place only abroad and not at home and only by a system of rental (within the country)

On May 27th 1907 was handed down a decision of the Imperial Court that patent No 105 762 machine to cover the sewing edges of inner soles with a reinforcement should not be canceled The fact alone that the owner of a mechanical patent merely hires out the machine made according to it will not suffice for cancelation of the patent according to section 11 clause 1 of the Patent Act when it appears that the hiring system brings economic advantage through the domestic production of goods by the machine That in itself the plan of using the machine by rental rests upon a sound economic idea cannot properly be doubted The court proceeded to cite statistics showing that the renting agreements of this sort in the business of a party here interested were numbered by the thousand It declared revocation in this case to be out of the question

D

Under what circumstances the authorities have cause to cancel patents is indicated by the following decision Patent No 57 020 winding machine was canceled December 4th 1907 by decision of the Imperial Court which said The machine in question now sells for a price of not less than 6 000 marks ($1 434) and therefore it cannot be denied that domestic industry has a considerable interest in its manufacture Such manufacture has not hitherto taken place but the machine is only imported from abroad hence the plea of the plaintiff shall be granted if the defendant cannot maintain special ground upon which the failure to manufacture at home can be justified

Section 11 of the Patent Act requires so far as possible the manufacture of the invention at home The patentee is consequently obligated thereto even at the sacrifice of an advantage he should not delay until the domestic manufacture becomes remunerative and must on his part make it appear that he has made earnest endeavors The defendant therefore should not have attached preponderant importance to the fact that a more extensive use has been obtained through the manufacture of his machines in America but should have presented conditions of license acceptable to domestic manufacturers That he could have found no licensees, cannot be accepted as proven

E

Offers to sell or license do not constitute the working of an invention

In one case the Court explained that while closing of license contracts affording assurance that an invention would be exploited in the country sufficed, this was not true of a mere readiness even if publicly expressed or of negotiations that miscarried and whose failure was not shown to be due to indifference of the other parties

In regard to patent No 29,352, "improvements in machines for reducing soft and yielding substances," the court ignored certain negotiations which had been made after issuance of the complaint in order to furnish proof that the machine could not be made in Germany for the American price. Examining a contract which the defendant had made for the construction and use of certain sizes, etc, in Germany, the court found that he had reserved the more important sizes and was supplying them, to a great value, from America Revocation was decreed.

Patent No. 104,556, "shoe-sewing machine appliance for varying the distance of the stiches from the edge of the sole' was canceled, the machines having been made abroad and imported. After issuance of the complaint, their manufacture had begun in Germany but only for lease to the limited circle using a sewing machine of a certain system. Here also the patent was revoked.

F

The revocation of a patent may be threatened if the holder of an improvement upon the invention be refused the use of the patent under a suitable license agreement with compensation.

G

A change of ownership taking place during the period of working does not exclude the right of revocation against a later proprietor.

It may be remarked in passing that in a typical case where this question was involved the fact that the earlier holder was engaged in American litigation over the invention was held to excuse his failure to work it meanwhile in Germany.

H

Partial revocation is permissible. This is only true, however, where the patent is divisible in its nature.—American Machinist.

LOCOMOTIVE ADHESION.

AN IMPORTANT FACTOR IN DESIGNING ENGINES.

THE adhesion of locomotive engines is a most important factor, says The Engineer, in the discharge of their duties. It has to be considered at every step in the preparation of a general design, for on it depends the carrying out of the work done on all the railways in the world, with the exception of a minute proportion of exceptional lines running up the sides of mountains. The word adhesion has a special significance attached to it. The late Bridges Adams, who had given it much consideration, always insisted on calling it "sticksion," because he said that word better expressed than any other the relation between wheel and rail. When writing about friction its amount is always expressed as a fraction of the weight or force pressing two surfaces together. Thus we may have a coefficient of 1/60th or 0.166 of the insistant weight, this representing the resistance to movement offered by the surfaces in contact. Furthermore, it is to be noted that the fraction is greater for bodies at rest than it is for bodies in motion. That is to say, to start a journal will require a greater effort than will suffice subsequently to keep it going. Locomotive adhesion, however, seems to be different in certain physical characteristics from friction. Its coefficient is enormously larger. It may reach as much as one fourth or 25 per cent of the load. It is commonly assumed that on British railways it will amount to one-sixth or 16.6 per cent. That is to say, let the load on a pair of wheels be eighteen tons, then three tons acting at a tangent parallel to the rail will be needed to make them slip, and as adhesion is the limiting measure of tractive effort, then, neglecting the resistance of the engine as a vehicle, it could exert a pull of three tons on the train behind it. All this is in a sense an old story, but the retelling of it will be found useful in clearing the ground.

There is no universally accepted theory of friction. The best is that illustrated by drawing one hair brush over another. The bristles become entangled or interlocked. In the same way the asperities of two metallic surfaces interlace, and in order that movement may take place the roughnesses must be dragged over one another or dragged off bodily. The old theory of unguents and oils and lubrication generally was that the oil molecules acted the part of rollers or balls. An asperity was dragged over another as we might put a stone in a wheeled truck and haul it up a mountain instead of letting the stone and the mountain come into direct contact. The more recent explanation of lubrication is simple. The oil gets between the surfaces and they never come into contact at all. Now in the case of the locomotive driving wheel there can be no uncertainty; beyond any doubt a kind of interlocking takes place. In the days of iron rails scales of metal torn from the rail tables in places where slipping took place were familiar objects glittering in the sun as they lay on the sleepers. We have had in our possession scales five or six inches long, three-fourths of an inch wide, and about as thick as bank note paper, torn off by a slipping wheel. In this case it will be seen that the slip was almost imperceptible, because the production of a long scale was only consistent with the advance of the wheel on the rail. The gap between the ordinary coefficients of friction for even dry surfaces and that between a wheel and a rail is so great that it is not easy to see that there is much in common between friction and adhesion, and this disparity is due to the very heavy loads forcing the tire and rail together. In our impression for March 25th last we showed how small is the contact area. There is, we think, no room for doubt that a direct interlocking of surfaces actually takes place, and that it is to this the relatively enormous coefficient of adhesion is due, and yet withal a few spots of oil or a little dirt, or a few dead leaves will cut the adhesion down to nothing and render an engine helpless.

A most interesting problem is presented by the question, How can the adhesion of locomotives be increased? If this could be done an immense advantage would be gained; the cost of engines would be reduced, their weight might be diminished, the wear and tear of rails and tires would be lessened. There can be no doubt that the single engine is superior to the coupled engine in every way but one—tractive power. We need do no more than refer to the multiplication of driving wheels as one expedient, but there are others; first of course comes the use of sand. No one understands why sand will run up the coefficient of adhesion to two or three times that existing without it. Do the particles imbed themselves in the wheel and the tire and establish a multitude of interlocking points? As first used, dry sand was simply dropped on the rail in front of the wheel and was for the most part wasted. To-day it is blown in in small quantity by a steam blast. It seems remarkable that no one has proposed sending a fine stream of sand and water on the rail. To judge by machines for sawing stone and marble it is probable that a much smaller quantity of sand would suffice, and it would not be scattered, as it is now, into points and crossings where, caught by the oil, it gives so much trouble that on some lines the use of sand is specially prohibited in stations and yards just where it is most wanted. Again, we have pointed out that static friction is much greater than dynamic friction. Now when a wheel rolls on a rail that portion of it bearing on the rail is at rest as regards the rail, and the coefficient of adhesion is high. Let the wheel begin to slip and it will instantly spin round; the friction has become dynamic instead of static. It is therefore of the utmost importance to prevent the inception of slipping. But slipping, other things being equal, will depend on the amount of the tangential effort. So long as that remains below a particular figure there will be no slipping. But the tangential effort is not constant; it varies constantly in amount during each revolution, for reasons which we need not stop to explain. The turning moment is much more even with three cylinders than with two, and more uniform with four cylinders than with three, always provided that care is taken to secure that result when designing the engine. The result is that for a given weight a four-cylinder engine will haul heavier trains than will a two-cylinder engine. Moreover, for passenger engines there is another consideration of much importance. At high speeds compensating weights do much harm, tending in each revolution alternately to lift the wheel off the rail and force it down. For this reason we seldom find that more than two-thirds of the reciprocating and centrifugal effort is balanced, and even if it were, it is highly probable that any locomotive running over 90 miles an hour would lift its driving wheels clear of the rails once in each revolution. It needs but a little thought to see that this action must reduce the tractive effort of an engine, and it will be at its worst in the simple engine. But with four cylinders the case is quite different. All the reciprocating and revolving masses balance each other, so that no compensating weights are needed in the wheels. Mechanical purists tell us, indeed, that as compensation does not take place in the same plane it is imperfect. But the compensation is quite good enough, and so we have another factor tending to promote adhesion.

Lastly, it may be pointed out that were it not for exceptions in the road and conditions of working the single engine would satisfy every demand that can be made on it, particularly if it was a four-cylinder engine. Most of the heavy pulling done by a locomotive represents acceleration, the work performed in getting up speed. If it were not inconvenient in other respects single engines could be assisted out of station by pusher engines, and would subsequently take care of themselves. The fact is that at high speeds locomotives do not make steam enough to utilize all their adhesion. An engine which can exert a pull of two tons must be exceptionally powerful, and 18 tons on a single pair of drivers would much more than give this. The effect of centrifugal effort mentioned above would not sensibly affect the pull until such time as the train charged an incline, when the resistance would sharply increase. Indeed, it is a common experience that an engine which is running without slipping on a line or down hill will begin to slip the moment an incline is reached. This is probably due in part to lifting of the wheels at speed. Four drivers and even six are used for fast passenger work solely to deal with comparatively small portions of most railways. At the worst they are never required for more than half their time. Many inventions have been made and patents taken out to augment the coefficient of adhesion. They have come to nothing. There is room to believe, however, that this is largely because no systematic practical study of the problem has ever been undertaken. Slipping is normally due to the rail being dirty. The coefficient of adhesion on a clean thoroughly wet rail is very nearly as high as it is on a quite clean dry rail. Much, we believe, might be gained by fitting engines with some device which would clean the rails before them; the surface is very small, a band, say, 2½ inches wide. It would be quite possible to fit a locomotive with two rotary steel wire brushes of considerable diameter which could be brought into use the moment the wheels began to slip. Again, it is possible that an extension of Stroudley's method of directing exhaust steam on the flanges of the leading wheels might be found to clean the rail. Be this as it may, when we consider how objectionable slipping is, and that it is always due to dirt on the rail, it seems clear that it would be worth while to attempt to clean the rails when they need it in advance of the driving wheels.

In a paper read before the American Chemical Society Mr. A. P. Steckel described a process for the electro-magnetic separation of non-magnetic non-conducting substances. The method described is the result of a study of the problem of obtaining a more thorough concentration of Lake Superior native copper ores, and the experiments were carried out at the Buffalo Smelting Works in the years 1905, 1906, 1907. For several reasons the desired result was not fully realized, but the method is interesting since it may succeed under more favorable conditions. The method is based upon the principle that an electrolyte carrying a current in a magnetic field tends to move across it, whereas non-conducting particles will be unaffected, and conducting particles will move with the liquid. It was assumed in designing the apparatus, that the liquid conductor carrying a given current across a field of given strength would be acted upon by a downward force similar to that which would appear in a solid conductor under the same conditions. As first constructed the apparatus consisted of a trough 1[illegible] inches long, 2 inches wide and 4 inches deep, placed in the gap of an electromagnet, and filled with water containing a few per cent of sulphuric acid. At the ends of the trough were carbon electrodes purposely set somewhat inside the bounds of the magnetic field and carrying direct current to the liquid conductor. Although the *performance of this* apparatus was in accordance with the theory of the process it was not found possible, owing to the agitation of the liquid, to attempt the treatment of finely divided material. Porous woolen screens near the electrodes did not stop this agitation, which was still quite violent, and there was always a marked tendency for the liquid to rise at the ends of the trough and to show a distinct depression in the middle. The liquid was rendered quieter by moving the electrodes from the ends of the trough to a point nearer the middle, leaving only 6 inches of liquid between them, but even under these conditions no satisfactory separation of the finely divided mixture of copper and rock was possible, although all the large particles of copper went to the bottom and all the large particles of rock remained on the surface of the trough. If a practically quiet condition of the liquid could be maintained in a trough of considerable dimensions the method would be of great value and would fully warrant the expense of installing and operating it. Exhaustive experiments proved, however, that with large electromagnetic forces the liquid could not be held quiet for reasons named in the original article.

A PROFILE PUPPET-SHOW.—II.*

HOW IT CAN BE MADE AND USED.

BY A. ROZE.

Continued from Supplement No 1795, Page 348

Attention must now be given to the all important part of the show namely the profile marionettes Procure some fairly stout cardboard that can easily be manipulated with scissors or penknife In the case of intricate patterns a small chisel can be used with advantage Having the materials and tools the showman can start making his figures an easy task if he carefully studies the illustrations to this article and fully digests the instructions

Fig 4 represents a Chinese bellringer which has five separate movements of the legs arms and body easily understood by referring to the back view (Fig 5) showing that the limbs of the figure are separate pieces and that the body is in two parts six pieces in all The different pieces are movable and held in their places by boring a small hole through the two pieces Then pass a thin piece of copper wire about half an inch in length right through then bend it flat against the cardboard figure (see left hand side of Fig 6) Then with a pair of round nosed pliers turn the wire round and flat against the figure as shown in Fig 6 right hand diagram Then with the end of wire on the other side repeat the operation This method will be the same for jointing all the figures Having completed the figure pierce holes with a stout needle through which the threads have to pass It must now be strung to make it work Procure some very fine black thread or silk making a small knot at the end and pass it through at the back of the figure to prevent slipping through and to secure it in its place A support for the figure is now required by which it may be worked by the manipulator This is technically called a crutch Cut from a flat piece of wood *B* (a cheap blind lath bought for a penny will serve) through which drill or bore four holes next two smaller holes in the center large enough to pass the threads through which are then knotted on the upper side of crutch at *C* to hold up the figure These are called life lines as they support the figure Next two narrow pieces of wood or small wooden rods will be required *C* and *D* Referring to Fig 5 it will be seen 4 connected with the arms and lower part of the body pass right through the crutch *B* the life lines being fixed as already described One arm and one side of the body is tied on to *C* the other arm and reverse side of the body are attached to *D* The length of the threads depends on the height of the scene over which the entertainer works They must in any case be of such a length that his hands cannot be seen by the spectators

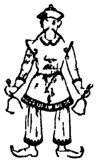
Fig 4

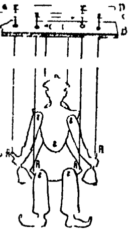

Fig 5

The figure now being complete hold the crutch *B* in the fingers of the left hand and then with the right hand manipulate the rods *C* and *D* When rod *C* is raised up one arm of the figure is lifted also the opposite side of the body the leg on that side swinging Then the rod *D* is moved and both *C* and *D* at the same time With a little practice and carefully worked the effect of a bell ringing and dancing mandarin will prove an entertaining and mirth provoking performance Two or three bellringers will prove more amusing than one All that is necessary will be to have a longer crutch The same method will work all the figures Two or three small sleigh bells (to be obtained at any toyshop for a few pence) rung at the side by an assistant and in unison with the movements of the figures will give a pleasing effect

Fig 7 shows an Eastern lady tambourine-player Fig 8 illustrates the crutch method of stringing up the figure the manipulation being the same as for Fig 5 and the action of the figure similar except that it will be noticed that the rod *D* will with a quick movement give the action of beating the tambourine The arms in this as in Fig 5 are attached behind Four or five figures all of which can be

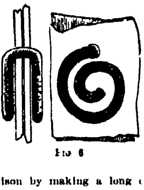
Fig 6

worked in unison by making a long crutch (as for the bellringers) will make an attractive and pleasing performance A quick and dexterous movement to the rod *D* will make it appear as if the figures are beating the tambourines The threads attached to the hands of the figures must be long enough to allow the elbows to nearly reach the lady's skirt when rod *D* is at rest—of the crutch *B* A tap with one or more

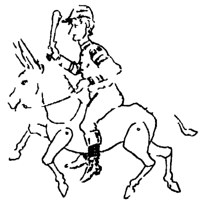
Fig 9

sticks on a tambourine at the side of the stage will greatly add to the effect

Fig 9 is a grotesque figure of a jockey on donkey back This will provide capital fun especially if several figures are introduced on one crutch and made to gallop to and fro before the audience finally galloping off and should meet with well deserved applause

Fig 10 shows the back view crutch *B* held in left hand and rod *C* worked by the right hand as in former figures but here the animal comes in Life lines as already explained for the figures will be

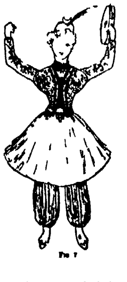
Fig 7

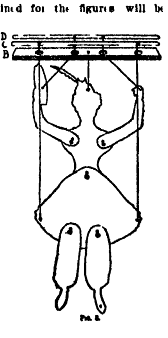

Fig 8

found to vary slightly for Fig 10, as shown at *A*—one for the head and tail of the donkey, and one for the head of the jockey *B* which latter is the all-important one The donkey is jointed in exactly the same way as the figures It will be seen that each leg of the donkey is in two pieces, the head and tail are also separate pieces the body of the animals and jockey in one piece, except the arms, which are fixed in the same manner as other joints, and left to themselves for eccentric movements A pair of reins made of string and fixed to the hand of the rider, a piece of wire forming the bit for the donkey's mouth The legs at *L* must have a thread attached which passes freely through the mouth and also at the tail at *F* The whole being made and fixed it will be found that by raising or lowering rod *C* the jockey and body of the animal will give a motion that will set the other parts in motion

(To be continued)

NEW CLINICAL THERMOMETER.

Consul General John L Griffiths finds that a great deal of interest has been manifested in the British medical world as a result of the invention of a clinical thermometer which it is stated automatically registers every fraction of a degree in the changing temperature of the patient Mr Griffiths forwards from London the following description of the instrument

The claim is made that hitherto it has been impossible to record with accuracy the fluctuations in the temperature of the human body either in sickness or in health If this is the fact it is evident that the invention which has just been perfected will open a very large field for research work in an entirely new direction The thermometer consists of a very fine flattened coil of platinum wire 1 250th of an inch in diameter wound on a thin strip of celluloid film This coil is then covered for the purposes of insulation, by a second thin film of celluloid The ends of the platinum wire are connected with ordinary copper flexible electric light leads An extremely sensitive galvanometer which will instantly record any increase or decrease in the amount of electric current passing, is let into the circuit The leads then pass to an electric recorder on which the extent of the variations in the current passing are noted by an upward or downward swing of an ink tipped pointer traveling on a continuously revolving paper covered drum or cylinder The principle underlying the thermometer is that any change in temperature of the coil of platinum wires will vary the amount of current which can pass through it this change being determined by the galvanometer and recorded on the revolving drum The thermometer which is in an insulated celluloid case, is to be placed in the arm pit and kept in position by a bandage which will pass over the opposite shoulder The arm will also be bandaged to the side in order to protect the thermometer from all atmospheric influences It is expected that this new instrument will be used chiefly in hospitals in the treatment of such diseases as typhoid fever and pneumonia —Weekly Consular and Trade Reports

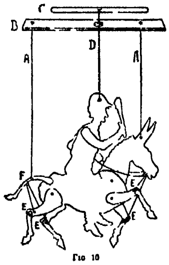

Fig 10

Statistics of aeronautical patents in recent years are given by Dr W A. Dyes in the Zeitschrift für Luftschiffahrt for February The number of complete patents granted in Germany was 73 in 1909, 36 in 1908, 27 in 1907, 14 in 1906. The corresponding numbers of provisional protections were 140, 48, 37, 14. In view of the fact that in Germany applications for patents are not published until the Patent Office has examined their validity, the author gives for comparison the number of applications filed by the English Patent Office in the same years, namely, 776 in 1909, 236 in 1908, 189 in 1907, 45 in 1906, and 19 in 1905.

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* English Mechanic and World of Science

COMPASS DEVIATIONS.

THE COMPASS ON BOARD IRON AND STEEL SHIPS.

BY WILLIAM C. WARD.

WHEN the shipbuilders commenced turning out iron and steel vessels navigators found themselves confronted with the problem of overcoming the magnetic forces of their ships and making their compass needles point toward the magnetic north. It became evident that the vessels themselves were tremendous magnets and disturbed the compass in different amounts for each direction in which the ships were headed, the quantity of the error being greater or less according to whether the ship's influence acted against or with the earth's total force.

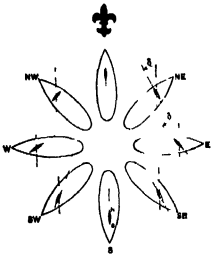


Fig 1.—Deviations Due to Sub-permanent Magnetism. Vessel Built Heading North; permanent N polarity in Bow

Any elongated mass of iron or steel, whether a bar or a ship, will, when lying in a northerly and southerly direction, acquire by induction from the earth's magnetic field the properties of a magnet. Should the iron be twisted or pounded while in this position it will permanently retain its acquired magnetism. Thus a vessel built heading north will have permanent north polarity induced in its stem with a corresponding south polarity aft, and one built heading northeast will acquire permanent north polarity on the port bow and south polarity on the starboard quarter.

When the vessels are on these headings after launching no deviations of their compasses from magnetic north will be noticed, for the magnetism of the ship and earth will act together in the same straight line. But let one of them be headed east, and it will be found that the north-seeking end of the compass needle is driven off to the westward by the repelling action of the north polarity in the forward part of the ship—more in the case of the first vessel than the second, because the repelling force is right ahead and more nearly at right angles to the needle's normal position.

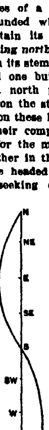


Fig. 2.—Curve of Semicircular Deviations of Vessel Build Heading North

If we now head this first vessel southeast the north-seeking end of the compass is still deflected to the westward, though less than before because the angle between the ship's and earth's force is more acute. On the south heading the ship and earth again act in line, and there is no deflection. There is an effect, however, because the ship's force strengthens that of the earth, and the needle has a stronger tendency to point north than under normal conditions. For the same reason the compass is rather sluggish when the ship heads north. As the ship swings from south to west the north-seeking end of the needle is deflected to the eastward of magnetic north and the error increases until it reaches its maximum at west, thence decreasing to zero on north. These deviations may be represented as a curve plotted from a base which is a straight line suitably subdivided into the points of the compass. Easterly deviations are plotted to the right of the base line and westerly deviations to the left, the curve of course crossing the line at the points of no deviation. These points are seen from the figure to be a half circle apart, and it is for this reason that the error caused by the permanent magnetism of the ship is called semicircular deviation.

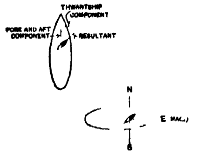


Fig 3.—Horizontal Components of Semicircular Deviations

The remedy obviously consists of placing a permanent magnet so as to counteract the ship's influence. Formerly this was done literally. The vessel was swung through the entire thirty-two points of the compass and the error carefully determined on each. From the data thus obtained a long tabulated form of computation was filled out and a result finally evolved which gave the angle between the fore-and-aft line of the ship and the axis of her permanent magnetism. There only remained to place a small steel magnet wrong end to, with its middle point directly under the pivot of the compass, turn it to the computed angle and raise or lower it until the compass showed proper magnetic readings.

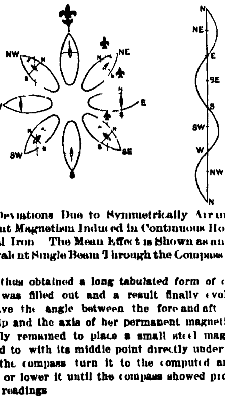


Fig. 4.—Deviations Due to Symmetrically Arranged Transient Magnetism Induced in Continuous Horizontal Iron. The Mean Effect is Shown as an Equivalent Single Beam Through the Compass

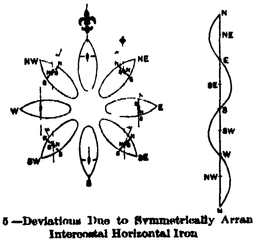


Fig 5.—Deviations Due to Symmetrically Arranged Intercostal Horizontal Iron

But the total horizontal permanent magnetic force of the ship may be resolved into two component parts—one fore-and-aft and the other athwartship. Usually we do not know how the vessel headed when building. In such a case when she is heading north the fore-and-aft component is directly in line with the earth's force and cannot cause any lateral deviation. If then the compass is found to read northwest when the ship is heading magnetic north, the thwartship component is causing the trouble, and the compass north is being drawn to the eastward by south polarity on the starboard side. We therefore place a steel magnet in the thwartship direction with its middle point in the fore-and-aft line of the vessel and its north pole to starboard, moving it toward or away from the compass until the correct reading is obtained on the compass card. Now suppose that the ship is headed east (magnetic) and the compass is found to read northeast. The thwartship component is now acting in line with the earth and can cause no error even were it not already compensated out. A permanent magnet placed fore-and-aft with its middle point in a thwartship line passing through the compass pivot, north end forward, will drive the compass north off to the left. By now moving this magnet toward or away from the compass until it reads north the fore-and-aft component will be balanced and the entire semicircular compensation completed. This latter method being much the simpler is used exclusively to-day.

Whatever permanent magnetism is imparted while building to the thwartship pieces of the vessel, as beams, etc., goes to form part of the semicircular deviation which has just been explained and compensated. But the beams of a vessel being very numerous (generally about two feet apart) and located just below the decks and near the plane of the compass, with their extremities comparatively near the midship line in which compasses are located, exercise a powerful influence of varying strength and character as the ship swings through the thirty-two points of the compass and the beams are brought to various angles with the magnetic meridian. As long as the ship heads north or south the beams are at right angles to the direction of the earth's lines of force and no magnetism can be induced. As long as the ship heads east or west, though the induced magnetism is at its maximum, there can be no lateral effect on the compass needle because ship and earth act in the same straight line. However, as the vessel's head swings from north to east the induced north polarity in the port beam ends repels the north-seeking end of the compass needle off to the right (eastward), reaching its maximum on magnetic northeast and from there diminishing to zero at east, where the now highly magnetized beams lie north and south. On headings between east and south the north ends of the beams again act across the line of the earth's force and drive the needle off to the west of magnetic north. Here again the deviation completes its cycle from zero to its maximum (on southeast) and back to zero on south, where the beams lie at right angles to the earth's force and take on no magnetism. In like manner easterly deviations are produced on southwesterly headings and westerly deviations on northwesterly headings. A curve of these deviations if plotted as before would cross the line on the cardinal points and exhibit maxima on the intercardinal points, from which circumstance this class of compass error is called quadrantal deviation.

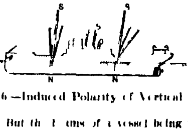


Fig 6.—Induced Polarity of Vertical Iron

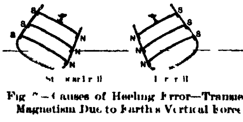


Fig 7.—Causes of Heeling Error—Transient Magnetism Due to Earth's Vertical Force

No system of permanent magnets can possibly correct this error, which ranges from zero to its maximum and back four times whenever the vessel is turned completely around. It is found, however, that a broken bar of soft iron intercostal with respect to the compass, and which is dependent for its magnetism upon the same conditions as the beam, must therefore cause deviations of a quadrantal character, moreover, such a bar—or two short bars or balls symmetrically placed in a thwartship line through the compass—will cause westerly error whenever the beams are causing easterly and the reverse. Here the south pole of the port bar attracts the north end of the needle to the westward where the continuous beam presented a north pole to repel it to the eastward and so on through the entire circle.

After the semicircular deviation has been compensated out by the permanent magnets as explained there only remains to head the vessel northeast (or some other convenient intercardinal point) and move the two iron balls or bars as much as may be necessary to make the compass give the correct magnetic reading.

The reason for heading the vessel north and east (or south and west) to compensate the semicircular deviation is now evident for it is on the cardinal points that the quadrantal is always zero. Having once removed the semicircular error it is best though not absolutely necessary to correct the quadrantal on the intercardinal points where it reaches its maximum.

In rare cases a small error is found which is the same on all headings. This constant may be due to either or both of two causes unsymmetrical soft iron in the neighborhood of the compass or the placing of the compass out of the fore and aft line of the vessel. In the latter case the remedy suggests itself in the former no attempt is usually made to compensate but the error is ascertained and allowed for in laying courses.

A freely suspended magnetic needle however, will not take up a north south position in a plane tangent to the earth's surface but will dip so that it points to the magnetic pole. Its position will be quite vertical at the pole and horizontal only at the magnetic equator. At intermediate points on the earth's surface various degrees of dip will be observed between these limits. Thus the earth's total force is made up of both a vertical and horizontal component. Iron masts smoke stacks boat davits stanchions and other up and down masses of iron which cannot be affected by the earth's horizontal force have nevertheless magnetism induced in them by the vertical component of the earth's total force and in north latitudes develop north polarity at their lower extremities. The effect upon the compass needle will depend on which end is nearer at hand for a compass placed halfway between the extremities would not be affected. The total effect of the vertical soft iron of a ship may be considered as one definite permanent magnetic pole of fixed position relative to the compass and therefore must cause semicircular deviation. In fact the error due to this class of iron is one of the elements that go to make up the total semicircular error.

As will quite naturally be expected the strength of this vertically induced magnetism varies with the latitude in which the vessel happens to be. Attempts have been made to correct it by means of vertical soft iron bars (Flinders bar) so placed as to present an opposite vertically induced polarity at the mean or resultant point of application of the vertically induced disturbing force. General practice however, is to swing ship for deviations and recompensate after any considerable change in latitude.

All that has gone before has referred entirely to ships on an even keel. The moment the vessel commences to roll existing conditions become modified and new forces are brought into play. As the ship heels say to port the port beam ends acquire from the earth's vertical component north polarity (in north latitudes) and the starboard ends the inevitable south polarity. The compass north will then be both repelled and drawn to starboard. On the starboard roll these conditions will be quickly reversed and the compass needle will be forced to port of its proper north direction. Thus while no fixed error will result the compass card will vibrate from side to side as the vessel rolls and the helmsman cannot tell within safe limits what course he is steering. To stop this swinging of the compass card a permanent magnet is suspended—latitude pole uppermost directly below the pivot of the compass. As long as the vessel is on an even keel there is no effect but as soon as she heels over the compass card tilting in its gimbals brings this heeling magnet relatively off to one side so that its upper pole counteracts the forces for the time being induced in the upper end of the beams.

THE NEW STANDARDIZED COTTON GRADES.

THE PASSING OF THE EXPERT.

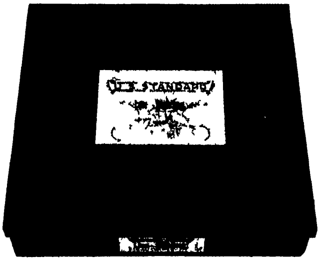
BY CHARLES RICHARDS DODGE

It has been held that the classification of cotton for trade purposes could never be an exact science but must depend more or less upon the discretion of experts and be open to honest differences of opinion. Reduced to a more direct form of statement it may be said that there have been no uniform standards of grades in the cotton trade grades of the same name in different exchanges differing considerably in quality thereby causing wide differences of opinion and much friction in market transactions. Now that a government standardization of grades for a proper and uniform classification of cotton has been effected when these standards are universally adopted as they are bound to be one of the chief causes of controversy in cotton trading whether relating to spot transactions or in the making of contracts for future delivery—will have been eliminated.

What the trade itself was unable to accomplish has been effected by officials of the Department of Agriculture without any flare of trumpets although the action of Congress authorizing the work chanced to be coincident with the *exposé* of the methods of conducting business in the cotton exchanges of the country which appeared in a special report of the Department of Commerce and Labor. It may be remembered that this investigation of the operations of the cotton exchanges was made by the Bureau of Corporations in accordance with a resolution of the House of Representatives particularly in regard to the classification methods then in vogue and to the range of contract grades these grades being used in connection with the business known as trading in futures. In the report which followed many suggestions were made whereby the system might be improved the importance of the early establishment of uniform standards of the leading grades of cotton in all markets being particularly emphasized. Some years ago attempts were made to secure such uniform standards by joint action on the part of leading cotton exchanges but the movement was without results and similar efforts made from time to time by the New York Cotton Exchange have failed to meet with response either from the other exchanges or from Liverpool.

The new government standards are the result of a provision which was included by Congress in the appropriation bill for the fiscal year 1908-09 for the purpose of securing the services of expert cotton classifiers in order to fix a standard for middling cotton to be used as a basis to establish standards for nine different grades these grades to be the official standard of cotton classification. The experts were to be selected by the Department of Agriculture though it was not proposed to make the standards established by them compulsory by law.

It should be explained that at this time eighteen grades of cotton were recognized by the New York and New Orleans cotton exchanges ten being full grades and eight being known as half grades the latter designated by prefixing the word strict. Those grades were as follows: Fair strict middling fair middling fair strict good middling good middling strict middling middling strict low middling low middling strict good ordinary good ordinary strict good middling tinged good middling tinged strict middling tinged middling tinged strict low middling tinged low middling tinged and middling stained. Prior to January 1st 1908 nine other intermediate grades were recognized these being known as quarter grades.



COTTON GRADE BOX SHOWING LABELS

For legitimate commercial purposes nine grades (as formerly recognized in the older classifications and as established by the new official standards) are all that are necessary. The classification of cotton is chiefly based on color and the amount of dirt and trash that it contains. The consideration of twice or thrice the nine grades is an absurdity for while there are experts who are able to detect very minute shades of differences practically no two experts in differentiating thirty grades or even eighteen would be able even to approximate the same results in independent examinations of the same lots of cotton. Hence the honest differences of opinion which arise in different exchanges.

The necessity therefore for a simple classification is obvious and it was the aim of the Department officials acting under the law of Congress to devise a natural and practical system of grades which after having been standardized by recognized experts might be maintained in Washington as types for purposes of future comparison. The Bureau of Plant Industry of the Department of Agriculture having been charged with the work—which was placed under the immediate direction of Dr. Nathan H. Cobb of the Section of Fiber Investigations with the authority of Congress and with an ample appropriation the Department began at once the selection of the standardization committee. At the outset the importance of securing as far as possible the most competent and widely known men in the cotton trade was fully recognized and in time the list of names of the gentlemen who would compose the committee was completed in its personnel all sections of the country and all interests in the cotton trade being represented. Meanwhile standardized samples representing the grades recognized by the cotton exchanges of the country had been secured and held under seal to be opened by the committee when it should meet in Washington to perform its work.

The committee was as follows: Joseph A. Airey (of John M. Parker & Co.) New Orleans James Akers (Inman Akers & Inman) Atlanta Clifton P. Baker (Lawrence Manufacturing Company) Lowell F. M. Crump (F. M. Crump & Co.) Memphis John Martin of Paris Texas George W. Neville (Weld & Neville) New York city I. W. Parker (treasurer Olympia Mills and others) Greenville S. C. Nathaniel N. Thayer (Barry Thayer & Co.) Boston and Charles A. Vedder (John D. Rogers & Co.) Galveston—with Mr. Thayer of Boston as chairman. This committee also had the assistance of three expert classifiers who aided materially in the preliminary work. They were Jules Mazerat chairman Classification Committee New Orleans Cotton Exchange W. P. Barbot Classification Committee New York Cotton Exchange and J. R. Taylor Classer of A. L. Wolff & Co. Dallas Texas. The foreign members of the committee were not present as it was not possible for them to attend so early in the year and it was important that the work of the committee should be finished before the expiration of the Sixtieth Congress.

These busy men unselfishly gave their time without compensation for the good of the trade and at the close of their labors presented a report which while extremely brief covered the whole ground. It was addressed to the Secretary of Agriculture as follows:

"Sir: Having been called upon by you to assist you in the establishment of a standard of middling cotton and using the same as a basis establishing a standard of nine different grades to be designated Middling Fair Strict Good Middling Good Middling, Strict Middling Middling, Strict Low Middling Low Middling Strict Good Ordinary, and Good Ordinary, in pursuance of the terms of the act of Congress upon the subject which standards should be the official standards of cotton classifications beg to advise that in pursuance of the instruction given us, we have made up types representative of each of the grades of cotton referred to above which we have delivered to your Department, and which we believe to be fair types of the different grades referred to."

It was pointed out by the committee that it would be unfortunate to have the standards used as a basis of sales in the middle of the cotton season, and that they should not go into use by the trade prior to September 1st, 1910. It was urged that the government should at all times maintain the strictest supervision of the preparation of the standards, these to be safeguarded in every way by such legislation as might be necessary to prevent their being tampered with

The date upon which the standards may be used by the trade is approaching Already they have been adopted formally by the New Orleans Exchange, and other southern exchanges are expected soon to follow, New York has not yet been heard from but it is known that the Exchange has the matter under consideration As to the foreign exchanges I can only refer to a recent conversation with Mr Jules Mazerat, the veteran chairman of the classification committee of the New Orleans Exchange, who stated that members of foreign exchanges visiting in this country are very much interested in the new standards and with their eyes open are simply waiting Mr Mazerat believes that the adoption of the standards by Liverpool and Manchester would mean practically their adoption throughout the world

The type samples of cotton which make up the nine standard grades are arranged for safe keeping in that number of heavy cloth covered cases measuring about twenty by twenty one inches and five inches deep each case being provided with a tight fitting hinged lid—a single grade the cotton samples arranged in twelve compartments being shown in each case This is made clear in our illustration although it should be explained that all which appears in the illustration above the words 'Do not touch the cotton is merely a bromide enlargement of a photograph of the cotton samples below which has been affixed to the inside of the cover of the case picture and samples being afterward photographed together As the most minute details of the surface of the cotton samples are reproduced in the bromide—such as the positions of particles of dirt or trash, or the lay of the cotton fiber itself—it becomes a telltale indicator any disarrangement interference or tampering with the samples being shown at a glance

The official label placed on the outside of the cover of the case bears (in blue lettering) the words Department of Agriculture | Official Cotton Grades (in gold lettering in an ornamental design) U S Standard (in blue) | American Cotton | of the grade MIDDLING (or other grade as the case may be) with the picture of an eagle in flight also in blue Then follows this notice The surface of the cotton alone shows the grade Keep the box right side up Keep the box closed when not in use as light and dust destroy the grade When issued each box bears the seal of the Department of Agriculture and the signature of the Secretary of Agriculture certifying to the grade on the date of issue The photograph represents the cotton on the date of certification

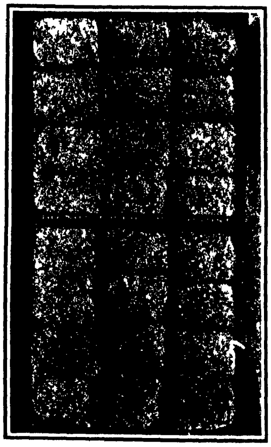
On the front end of each case or box appears the seal of the Department with the words Official Grade Middling (or other grade) in blue The accompanying illustration shows the manner of securing the labels to the case

The work of grading the cotton samples to standard is carried on by the Department in a special room that has been provided at the top of a building where the light conditions are as nearly perfect as a careful study of the requirements and the application of scientific principles can make them The examination tables are arranged some twenty feet below the sky light which has a pitch or inclination of fifty three degrees A pitch of seventy two degrees as recommended by the United States Naval Observatory authorities gives perfect immunity from sunlight at any hour of the day, but this inclination also lessens the volume of light on account of the direction of the light as it enters through the intervening glass With a pitch of fifty three degrees better lighting is secured and in the event of a straggling ray of sunlight entering it can be screened off readily by a narrow adjustable curtain In finding a location for the grading room, the danger of color reflections from adjacent buildings was duly considered pure well diffused north light without bars of shadow from the skylight framework or supports being absolutely essential in the work of grading cotton samples to standards

As lighting conditions must vary in the different laboratories where such grading work is carried on and as the types preserved at the exchanges are bound to deteriorate in time and in different degree, the advantage of having always available in Washington an official set of true standardized types of grades, for the settlement of disputes, is obvious

COTTON STANDARDIZATION ROOM.

The old problem of regenerating or devulcanizing waste vulcanized rubber is once more made the subject of a patent, granted this time in France to J C Bongrand According to the patent, one part by weight of finely-ground waste is added to 2 to 3 parts of melted paraffin wax (or other oil or fat), and heated at 130 deg to 150 deg C until it is completely dissolved Lead acetate, or other suitable salt of a heavy metal, is added to the hot mass, and the mixture is thoroughly agitated, in order to precipitate the sulphur as metallic sulphide. The mass is then either (1) extracted with acetone, which removes the paraffin wax as well as oils resin, etc, and leaves the regenerated rubber still containing all other loading materials or (2) cooled dissolved in benzine, petroleum ether or other solvent of unvulcanized rubber and paraffin wax the solution freed from mineral matter by decantation or filtration and the rubber recovered after concentrating the liquid at a low temperature by precipitation with warm acetone The rubber is washed with boiling acetone and dried preferably in vacuo



OPEN BOX OF GRADED SAMPLES

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USES OF OLD ROPE

CONSUL GENERAL ROBERT P SKINNER of Hamburg discusses in a practical way the various uses to which old rope is put at the present time

My American inquirers apparently are misinformed in understanding that German paper manufacturers have discovered an economical method of removing heavy applications of tar and graphite from old rope Furthermore its market price is such that German manufacturers are not interested in making experiments along this line Heavily tarred old rope is worth more today for making oakum than is lightly tarred material and it does not seem probable that these conditions will undergo any substantial change

The business of collecting and classifying old rope is an important one in every seaport Old hemp ropes are nearly all tarred but there is a small portion of such cordage which has been used for hoisting purposes or for tying logs into rafts, and this portion is not exported being converted in Europe into cigarette paper

More frequently hemp ropes are lightly tarred the original heavy coating having been washed off by water or melted off by the sun, and can be used for making a cheap grade of oakum, but are used principally in paper making In Europe the lighter tarred ropes are utilized to a small extent for cigarette paper but principally for heavy manila called papier goudronné For this the tar remaining in the rope is regarded as desirable In America few millers use this raw material and little of it is exported to the United States

OAKUM PRICES—HEMP WASTE—OLD MANILA

The best oakum rope is called wergau in German cordage pour étoupe in French and is worth about 3¼ cents per pound in America The lighter tarred hemp rope is called in German getweertes hanftau and in French cordage demi goudronné and this is worth in the United States about 2¼ cents per pound which explains clearly why it is not worth while to remove the heavy coat of tar for converting the rope into paper

The scraps and waste from these tarred ropes and also the old oakum removed from the seams of ships are used for making boards and leather boards This waste was formerly exported to the United States but latterly American paper makers have found other materials seemingly more suitable for their purposes The hemp waste is called in English tarred hemp shakings in German lumptau and in French cordilles de chanvre goudronné and it is worth in the United States 1¼ to 1½ cents per pound

Old manila rope has quite another set of applications This also comes either white untarred or tarred Of the white large quantities are collected the most of which goes to the United States The shipments to the United States average 2 000 to 3 000 tons per month American manufacturers using it for producing rope and insulating papers It is worth 2¼ to 2¾ cents per pound The American price is held down so it is said by a buying combination of consumers Some years ago the manufacturers had driven the price of this article up to 4½ and 5 cents per pound whereas intrinsically it should not be worth more than 3 cents

MANILA ROPE PRICES—CHANGING CUSTOMS

Manila rope when tarred heavily is not exported and is worth ¾ of a cent to 1 cent and when lightly tarred 1¾ to 2 cents per pound Its exportation to the United States is trifling European manufacturers absorb most of it for manila and bag papers Dutch French and English ports are the principal sources of supply of tarred manila rope whereas Hamburg supplies scarcely any of this grade Some manila rope is not tarred but tanned when it is of less value than if tarred

I am unable to learn that any graphite is used in this country for impregnating rope I am also informed that American manufacturers who ten or twenty years ago used rope or jute stocks are now working principally with sulphite pulps soda pulp or so called kraft pulps for the same purposes By using the newer raw materials which will produce a fair paper they get a larger output from their mills although the quality is not so strong or durable Rope stock must be cooked much longer than modern pulps This changed custom has decreased the value of old rope and old bagging considerably though the demand for paper has increased within twenty years so enormously that ropes and bagging formerly the sole raw materials could not now be furnished in sufficient quantities to satisfy the requirements of manufacturers —Weekly Consular and Trade Reports

CANADIAN PULP MAKING.

A PLANT IN THE ALGOMA DISTRICT, ONTARIO.

BY FRANK C PERKINS

At the present time there is great interest in the pulp and paper industry in Canada where there is available an abundance of water power and an abounding supply of raw material In the Algoma district of the Province of Ontario with its vast spruce forests and its extensive water power many desirable conditions are offered to the manufacturer of pulp and paper

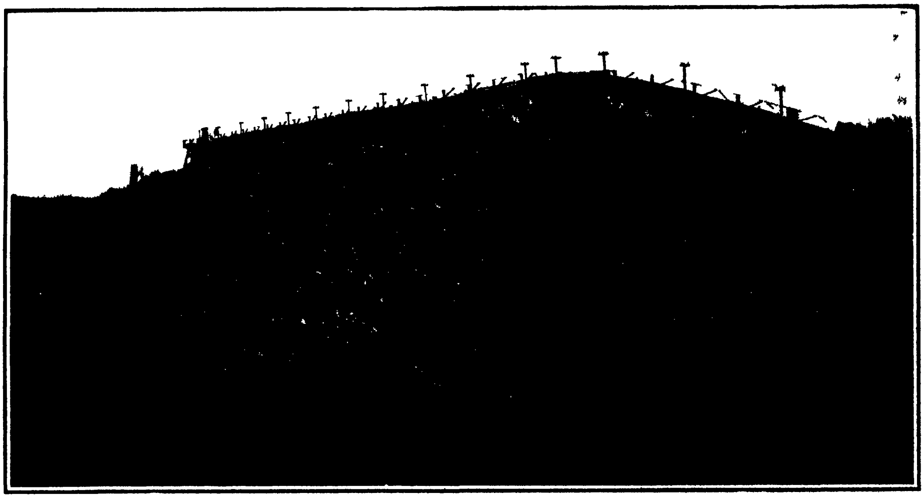
On account of these advantages a great pulp and paper plant has been established at the little town of Espanola on the Spanish River This stream some 200 miles in length has its source in Lake Biscotasing It follows a winding course to the shores of the Georgian Bay many important waterfalls interrupting its progress one of the finest of these as shown in the accompanying illustrations being in the neighborhood of Espanola where the plant of the Spanish River Pulp and Paper Company Ltd has been located and from where the pulp is shipped The present installation has a capacity of 1 0 tons air dry weight per day This pulp mill is equipped with the latest machinery as indicated in the engravings and it contains twenty four grinders eighteen wet machines and twelve 450 ton hydraulic presses

At this Spanish River power plant a head of 62 feet is available from which 30 000 horse power can be developed although only 15 000 horse-power is now being utilized

A half a decade ago a number of capitalists on recognising the immense possibilities that lay in the establishment of a pulp and paper industry in the Algoma district secured a concession from the Ontario government and at once proceeded to erect a modern plant at Espanola

It will thus be seen that this great undertaking is of comparatively recent growth Success however was assured from the outset by reason of the sagacity and foresight of its promoters who secured timber limits comprising an area of about 5 000 square miles in the territory drained by the Spanish River

A sufficient supply of raw material was thus provided and recently during a single season 65,000 cords



30 000 CORDS OF PULP WOOD AT THE SPANISH RIVER PULP MILL

PULP MILL OF THE SPANISH RIVER PULP AND PAPER COMPANY.

CANADIAN PULP MAKING

of wood were cut. The annual output of the Spanish River pulp mills is said to be 60,000 tons and it finds a ready market in the United States particularly in Illinois, Indiana, Wisconsin, and Michigan

It is interesting to note that in 1905 the Canadian paper making establishments employed about 5,000 men, the wages being over $2 000 000 and the product valued at nearly $10,000,000 the total investment being about $21 000,000

In the wood pulp establishments the material provided had a value of nearly $4 000 000 About $1 000 000 was paid in salaries to 2 456 employees while the total investment was about $11 000 000 It is maintained that the past five years have shown a wonderful increase in the output of the Canadian pulp and paper mills, and that the growth is the result of the heavy demand for the raw material being met through the utilization of the country s vast and available water power

IRISH LINEN AND SOME FEATURES OF ITS PRODUCTION *

By Sir William Crawford

The first use of linen as an article of clothing is veiled in the mists of antiquity Linen is mentioned in the Book of Genesis as already in use for robing the royal princes of Egypt and throughout the Bible it is very frequently referred to in terms of appreciation and as a symbol of purity and excellence But it is needless to refer to history in order to prove the ancient use of linen for considerable quantities of it are actually preserved for us in Egyptian tombs and acknowledged to be of the respectable age of fifty centuries or so And this Egyptian linen is made of flax which examined under the microscope is quite similar in fiber to the flax we use to-day I may add that some Egyptian linen is marvelously fine and so thick in proportion to its fineness that nothing similar has been woven in modern times But the subject I wish to treat of is modern linen of a single locality and a few special features of its production

SPANISH RIVER WATER POWER AT ESPANOLA ONTARIO CANADA

Irish linen is of world wide fame and perhaps examination of its manufacture may help to explain why it is so The moist and mild climate of Ireland is admirably suited for the growth of flax and for the successful carrying on of every process of its manufacture up to and including that of bleaching The flax plant has a thin wiry stem of about three feet branched only toward the top to carry the pretty blue flower and the bolled fruit which contains the linseed The fibers run in strands between the skin of the stem and the woody pith forming the center of the stem When flax is grown for fiber it is never cut but is pulled up by the roots soon after the fruit is formed When pulled at it is at once placed in sheaves in three or four feet of water generally in a slanting position with the top upward It is there loaded with stones or other heavy material to keep it under water where retting or fermentation proceeds The object of retting is to facilitate the separation of the fiber from the skin and woody substance After ten days or so it is taken from the water, dried and the fiber is separated To effect this the flax is bruised and scutched i e beaten by revolving blades of wood The fiber is then taken to the spinning mill Various flax producing countries carry out this process with more or less care Whether flax is to be spun into yarn by hand or by machinery it has to be hackled that is to say combed over sharp pointed pins till the strips of fibers removed from the stalks of the

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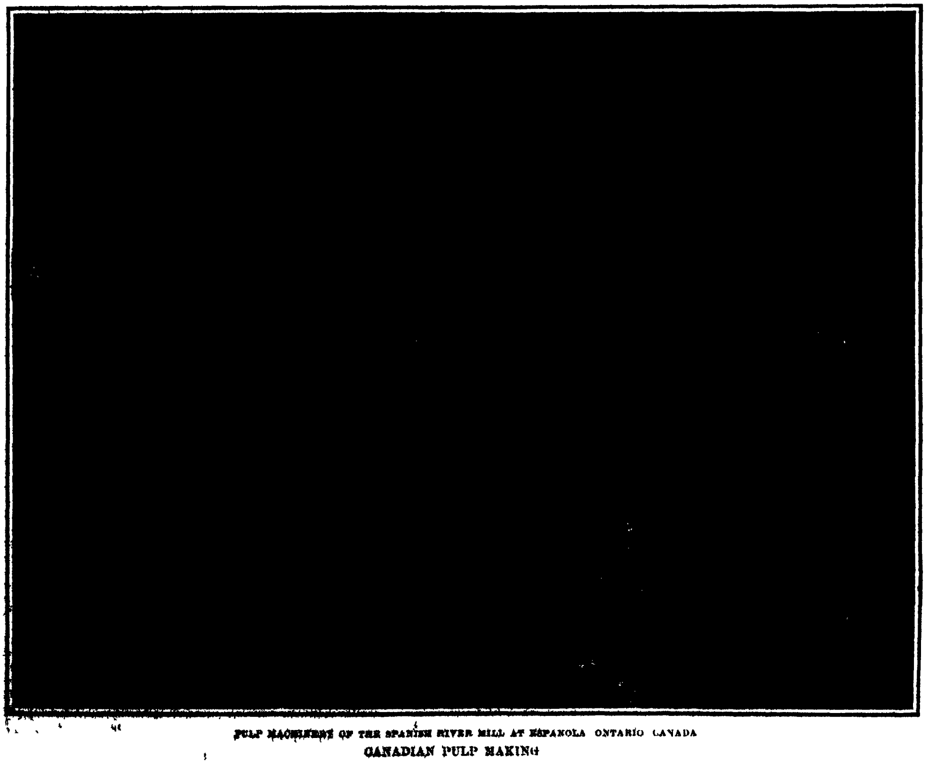
* Journal of the Royal Society of Arts



PULP MACHINERY OF THE SPANISH RIVER MILL AT ESPANOLA ONTARIO CANADA

CANADIAN PULP MAKING

flax plants are divided into apparently single fibers This division is only apparent as the ultimate fibers of the flax plant are about 1½ inches long tapering at each end to an exceedingly fine point A great number of these ultimate fibers are stuck together by the natural gum in the plant and form what look like the long fibers resulting from the hackling

When flax is to be spun by hand a bundle of this hackled flax is put upon the distaff and a few of these long fibers differing in number according to the fineness of the yarn to be spun are by the selection of the spinner and without any further subdivision introduced directly into the yarn as it is twisted and wound on to the bobbin in the spinning wheel

SAWING MACHINES IN OPERATION CUTTING LOGS FOR USE IN MAKING PAPER PULP

A CANADIAN PULP MILL.

The process of hand spinning though producing a better thread is by its nature impossible of application to the spinning of yarn by machinery as the spinning frame cannot make that selection of individual fibers which takes place in hand spinning Therefore in machine spinning quantities of hackled flax such as are put upon the distaff of the spinning wheel are fed into a machine called a spreader each quantity or piece overlapping the preceding one These all issue from the machine in one continuous riband or sliver which is too thick and too irregular to form yarn Uniformity is therefore secured by doubling and fineness by drafting or drawing out till it finally appears in the form of rove a loosely twisted thread of from five to twenty times the thickness of the yarn required This rove passes into the hot water trough of the spinning frame where the natural gum holding together the ultimate fibers of the flax is softened and upon issuing from the trough the rove passes between two pairs of rollers the second pair running faster than the first pair which draw these fibers past each other thereby extending and reducing the filament to the required degree of fineness and deliver them to the flyer which twists them up tight and winds them on to the bobbin The subsequent drying of the yarn hardens up again the natural gum of the flax plant and gives the yarn the firmness required to allow of its subsequent handling in the manufacture of cloth or thread

About eighty years ago a great transformation in flax spinning took place in Ireland Prior to that time linen yarn was there spun only by hand on the old fashioned spinning wheel In the year 1828 Messrs Mulholland s cotton mill was burned to the ground They at once with the enterprise that distinguished the family decided to rebuild it as a flax spinning mill That mill started work in 1830 in Henry Street Belfast Part of those same buildings still contain the offices of the York Street Flax Spinning Company Ltd About the same time Messrs Murland of Castlewellan also began flax spinning by steam driven machinery Messrs Hind and others in Belfast followed and by 1850 there were in Ireland 325 000 spindles producing linen yarn The beginning of the change from hand spinning had already taken place forty years earlier in England flax spinning machinery having been invented by John Kendrew and Thomas Porthouse, at Darlington, in 1787 Their spinning frames were rude and suited only for coarse yarns but Mr John Marshall of Leeds having taken the invention in hand improved it and he also developed the industry and founded a large business Machine spinning spread also in Scotland where a mill was erected near Glamis in 1790 But although Ireland was last to begin not many years elapsed ere it was abreast of England and Scotland In 1850 Ireland had as I said 325 000 spindles England had 365 000 spindles and Scotland 303 000 That is to say there was in 1850 about an equal number of spindles in each and a little later in 1856 England attained its maximum with 440 000 Since that time its spindles have decreased until now the linen trade there seems to be near to the vanishing point with less than 70 000 spindles Even the Messrs Marshall have found it necessary to wind up and close their once famous mills in Leeds and transfer their business to the United States of America where their mills now form part of the Linen Thread Company or Combine Scotland reached its maximum in 1871 with 317 000 spindles now it has 160 000 while Ireland s share has increased by a larger number than the other two have lost Ireland had in 1875 906 000 spindles in operation In 1888 it had 803 000 It has now 935 410 spindles belonging to some fifty different companies seventeen of them in Belfast one in Cork and the others scattered throughout Ulster One of the reasons of this great displacement in favor of Ireland is because it has practically this one textile industry only whereas England and Scotland have others which have allowed of a higher profit, and the payment of a higher scale of wages The number of persons employed in textile factories in Ireland in 1907 was Flax 70 382 wool and worsted 4 103 cotton, 403, silk, 250 and hosiery 554

An average sized flax spinning mill may contain 20 000 spindles and a mill of that size would give employment to about 750 persons It would to day cost $30 to $40 per spindle to erect it that means $600 000 to $800 000 The management of such a mill will consist of

1 The owners of the mill or directors of the company owning it

2 A mill manager

3 A head spinning master a head preparing master, and a head sorting master

4 A flax buyer and a yarn salesman

The workers are employed in the proportion of two or three females to one male A few children of both sexes and of 12 to 14 years of age, are employed as learners These are what are called "half timers", they work and go to school on alternate days, and they cannot be admitted to work unless they attend school

About $375 are spent in turning $500 of flax into yarn another $375 in turning that yarn into brown linen and about $250 in turning that brown linen into white goods ready for market Thus on $500 worth of flax about $1,000 is spent, chiefly in wages, and the finished product is worth $1,500

The flax used in Irish mills is the produce chiefly of four countries—Ireland Belgium Holland, and Russia

A new outlet for linen yarns has recently been opened up by the introduction of linen mesh underwear Ordinary flat woven linen was not porous enough or elastic enough for underwear but now, by a peculiar system of knitting (or rather by a combination of the two processes of knitting and of weaving) those difficulties have been overcome and a fabric is produced satisfying all the requirements of hygiene and eminently suitable for wearing next to the body Already this new material has met with very considerable success both in this country and abroad It is worn and recommended by leading members of the medical profession and persons who have once experienced the comfort of wearing it are not likely to go back to any other fabric It is a well known fact that linen possesses therapeutic properties which are not found in any other fiber, it does not irritate the skin or clog the pores, and at the same time it allows of adequate ventilation I am confident that this new linen fabric will ere long be largely adopted as a material for underwear

The flax spinning business has come through a good many fluctuations of fortune Sometimes it has been proverbially profitable and much oftener it has been quite the contrary For instance during the American civil war, the shortage thereby caused in the supply of raw cotton turned so many people to the use of linen that the price of linen goods became greatly enhanced and so during the years 1863 8 spinners made large profits During that time of prosperity a great increase in the number of spindles took place But of course when cotton supplies assumed their normal proportions the demand for linen goods diminished and for the next thirty years or so there were about seven lean years to one fat one No fewer than thirty six spinning mills were brought to insolvency or at least to such serious financial difficulty that eighteen of them with 200 000 spindles ceased to exist the other eighteen continuing under new owners but even of these eighteen six have changed owners twice while one of the largest mills lived through the long protracted crisis in so crippled a condition that it was unable to pay any dividend to the shareholders during more than twenty consecutive years On the other hand a few mills in specially fortunate circumstances maintained a moderate degree of prosperity and even increased the number of spindles owned by them

I may now tell you something about the weaving factory In spinning we had the transformation from hand spinning to mill spinning In weaving a similar transformation took place Ireland began after England and Scotland to use the power loom for linen weaving and in this also it has outstripped them There are in Ireland 36 000 power looms, owned by 100 companies, 21 000 of these looms are working in Belfast 13 000 in other parts of Ulster, and 2 000 scattered in small factories in Dublin, Cork, Dundalk and Drogheda As compared with the 36 000 power looms in Ireland Scotland has 17 000, and England 4 400 using linen yarn

Eight weaving factories in Belfast and eight in other parts of Ireland are attached to spinning mills, but that system is not growing In 1872 9,000 looms were attached to mills, now the number is a few hundred less The growth or extension has been in factories separate from mills, in 1872 they were 9 000, now they are 27 000 looms The chief cause of the growth of factories separate from mills is that a factory must be placed in proximity to a center where workers are to be had who have some dexterity in handling yarn or in weaving, while any saving effected by obtaining yarn from one s own mill is but small

A power loom factory for the weaving of light and narrow linens will cost $200 or $250 per loom A factory for making wide damask or sheetings will cost $500 and up to $1 000 per loom The management of a weaving factory is composed of (1) the owners of the factory or the directors of the company owning it, (2) a manager, (3) a foreman in the department where the yarns are prepared, with, under (4) a foreman over the warp winding a foreman over the weft winding and a warping master, (5) a number of tenters each one of whom supervises fifty to seventy looms Generally speaking, one weaver attends to two looms, but for wide goods there is a weaver to each loom Women attend to the looms weaving narrow and light cloth, and women also sometimes attend to looms making wide and heavy cloth but many of such looms are attended to by men

Wages are paid by piecework and the same scale applies to men and women The light end of the work is done by women, the heavy end by men, and between the two by either sex The wages of tenters and other skilled men are comparatively high The number of all persons employed in and about a weaving factory is somewhere about as many as the looms it contains

The yarn coming into a weaving factory is in bundles of hanks. For fine linens the yarn is boiled to render it soft and flexible The warp yarn is taken into the winding department, where from the hank or skein it is put on spools, which are taken to the creel and transferred to a warper s beam Several of these warper s beams are put on to one weaver s beam, and during this process the yarn is dressed or sized After the yarn has been put on the weaver s beam the ends of the threads are drawn through the heddles and the reed These all—beam yarn heddles and reed—are then ready to be placed in the loom so that the weaving may proceed The weft yarn is wound from the hank to a pirn, which is put into the shuttle which carries it swiftly back and forward across the loom leaving the thread inside the shed of the warp

During the hand loom period different classes of linen goods had each its locality of manufacture The Huguenots, who introduced fine weaving into Ireland settled at Lisburn and Lurgan Louis Crommelin born in 1652 at Armandcourt in Picardy and engaged in the linen trade there was by the revocation of the Edict of Nantes forced to fly the country He was settling in Holland when on the invitation of William III he and his son came to Ireland and by letters patent he was in 1699 appointed Overseer of the Royal Linen Manufacture of Ireland He brought other Huguenots over to assist him They settled at Lisnagarvey now called Lisburn which was then a ruined village, soon however they changed the whole aspect of the place into one of prosperity They taught the farmers improved methods of growing and treating flax introduced into the country better spinning wheels and looms, and taught how to manufacture cambrics and other fine linens For the stimulus Crommelin gave to the linen industry he was voted the thanks of the Irish Parliament He died at Lisburn July 14 1727, aged 75 years and is buried with other Huguenots in the eastern corner of the church yard One of his descendants Mr Nicholas Delacherois Crommelin was managing partner of the York Street Flax Spinning Company when fifty years ago I was serving my apprenticeship there Since the settlement of the Huguenots the Lisburn neighborhood has continued to be the center of the manufacture of cambrics and lawns damasks and bordered linen and cambric handkerchiefs The word cambric comes of course from Cambrai diaper is cloth d Ypres and the word lawn is probably named from the town of Laon Light shirting linens had their chief center in Ballymena and a great amount of business was done there In olden time and until say fifty years ago the weaver himself brought his web into the market and sold it By degrees that manner of doing business was superseded by a middleman or so called manufacturer who bought yarn in large lots from the spinner prepared the warps and gave them out accompanied with sufficient weft to the weaver One of these manufacturers might succeed in having hundreds of weavers thus working for him It was then he who brought the accumulated webs to market Forty years ago a hundred such manufacturers used to be present at the weekly Saturday market to dispose of the webs of linen which had been woven for them in the surrounding cottages Thirty years ago the webs offered for sale on a Saturday sometimes numbered 20 000 The York Street Flax Spinning Company have it on record that in 1880 in a time of stagnation, the Ballymena manufacturers had a stock of 40 000 webs These were worth about $1[illegible] per web of which the weaver s wages had been something like $[illegible] a web Ballymoney had a reputation for a rather better quality than Ballymena and Coleraine a little better still In County Down were woven the heaviest and best shirting linens Armagh gave its name to the very coarse linens used as buckrams and linings the trade name of which was Armaghs Randalstown produced mosquito nettings and creole checks which were largely shipped to New Orleans

But all these hand looms are fast becoming a thing of the past In every class the power loom is superseding the hand loom In 1893 I had occasion to estimate the wages paid annually for hand loom weaving in Ireland and arrived at a sum of $1 100 000 I estimate the amount so paid now at only $27 000 Parliament in passing the Handloom Weavers Protection Act which came into operation on January 1st 1910 has made an effort to revive the hand weaving of damasks cambrics and diapers and those engaged in that branch of the industry are laudably striving to take advantage of it A few years will tell whether or not it will have the desired effect Another recent Act of Parliament is unintentionally operating to the reduction of hand weaving as many old people still able to weave a little have abandoned that work on getting their old age pensions

(To be concluded)

THE MOTIONS OF THE EARTH.

THE TWENTY-THREE INFLUENCES TO WHICH THE EARTH IS SUBJECTED.

BY EDGAR LUCIEN LARKIN.

Along with the sun and its stately retinue of planets satellites asteroids comets and meteors the earth ever moves through infinite space with a velocity of about twelve miles per second in the general direction of the star Vega Since this majestic motion was discovered it has been sought to determine if the sun s pathway is curved or straight but so far without success Beyond doubt however it is a curve since it is almost impossible for our own or any other sun to traverse a straight line The motion of bees in a swarm are comparable to those of all suns in space deeps Another motion is that around the center of gravity of the combined masses of the sun and earth in a period of 31 558 149 seconds or 365 days 6 hours, 9 minutes 9 seconds This motion is that based on the supposition that no other bodies beside the sun and earth are involved A third motion is around the center of gravity of the entire solar system This point constantly shifts slightly owing to varying positions of all the planets This motion of the earth is complex A fourth motion takes place around the center of gravity of the earth and moon considered to be the only bodies attracting each other There is a fifth motion around the center of gravity of the sun, moon, and earth considered by themselves And this movement is also complex Motions 6 7 8 9, 10 11 and 12 are in obedience to the gravitation centers in between the earth Mercury Venus Mars Jupiter Saturn Uranus and Neptune Those motions are perturbations and are as difficult to compute as any in astronomy A thirteenth motion is a slight perturbation due to the feeble attraction of the asteroids a fourteenth, an increase of the orbital speed of the earth caused by the impact upon it of meteorites increasing its mass slightly The fifteenth is a minute perturbation doubtless due to comets and cosmical dust In a sixteenth motion we trace a theoretical increase in the velocity of the earth around the sun, due to any resistance it may encounter in ether Precession is the seventeenth motion The poles of the earth revolve around the poles of its orbit in periods of 25,787 years each This movement is comparable to the motion of the axis of a gyroscope This terrestrial motion is caused by the difference of attraction of the sun on the earth as an exact sphere and upon its equatorial bulge A diameter of the earth through the equatorial plane is 27 32206 miles greater than through the poles This protuberance, or massive ring around the earth, corresponds to the heavy rim of a gyroscope. Imagine that the axis of a gyroscope is pencil tipped and prolonged Set the disk horizontally, spin rapidly, thus the pencil point will describe a circle around a dot on the ceiling of the laboratory room The huge circles described by the poles of the earth are in diameter twice the obliquity of the ecliptic. Any stars passed by the earth's poles in this majestic motion become polar stars for the time being

Nutation is the eighteenth motion The polar pencils would mark out smooth curves if the equatorial ring were acted upon by the sun only But our exasperating moon in circulating around the earth once each month helps the sun pull the ring during half of the month and opposes it during the other half This causes the poles to move inside and outside of a true circumference and traverse a wavy path made up of these semi monthly undulations This is called nutation a word meaning nodding The moon makes the earth s poles nod The sun also causes the earth s poles to nod slightly as it passes to the north and south of the equator which is the eighteenth motion

The obliquity of the plane of the earth s orbit changes This is the angle in between the planes of the equator of the earth and its orbit and is now 25 minutes of arc less than it was 2 000 years ago It will diminish during 1 000 years in the future and then increase But this causes the earth to move in latitude (its twentieth motion) or north and south of a mean position

The orbit of the earth is not a circle but an ellipse a curve like that of a flattened hoop with one diameter longer than the other But the long diameter is now shortening and will so continue during 24 000 years and then lengthen This causes a twenty first motion of the earth toward and away from the sun

The earth has an axis of figure but it does not rotate precisely around this but another nearly coincident A titanic force is here exerted on the globe for it wobbles it does not turn invariably about one permanent axis but shifts the displacement being 3[illegible] feet approximately The poles traverse an irregular circle of about 70 feet in diameter in periods of 427 days each A mathematical research revealed that if the earth were absolutely rigid one revolution of the poles would be made in 305 days The excess of 120 days is due to the fact that it is not absolute in its rigidity it yields a little and the amount of yielding is "half that in a globe made of solid steel" The causes of this obscure twenty second motion or wobbling are unknown but are thought to be the attractions of the sun and moon The persistency of plane of rotation of the earth is overcome by this colossal force and turned aside slightly The power whatever it is is able to overcome the momentum of rotation of the huge globe in one plane and establish another The earth's interior may not be homogenous and differences of attraction exerted by the sun and moon on places within of unlike specific gravity may possibly be causes of this remarkable motion of the terrestrial sphere The discovery of this minute movement was a tribute to the high degree of accuracy of modern measurement This motion was discovered by means of refined determinations of latitudes made by observing stars These were found to vary slightly that is distances of fixed telescopes from the equator of the earth varied within narrow limits

Rotation of the earth once in 24 hours is a twenty third motion

These twenty three motions of the earth are of the entire globe as a whole Perturbations are perplexing but must be computed when calculations are being made for navigators for the moon s places and for eclipses and transits It is impressive to observe the effects of planetary perturbations on the earth s motions They are quite apparent in their variations of times of the earth s passage of perihelion Here is a table giving these disturbances for several years

Years	Times of the earth s perihelion passage
190	January 3 d 8 h
1904	January 2 d 11 h
1904	December 31 d 12 h
190	
1906	January 2 d 23 h
1907	January 1 d 14 h
1908	January [illegible] d 5 h
1909	January 2 d 13 h
1910	January 0 d 18 h
1911	January 2 d 22 h

Thus in 190 the earth was not at its perihelion at all but twice in 1904 Jupiter with its huge mass causes more perturbation than any other planet There are motions within the earth and of its surface Vast areas slowly rise and subside oscillating in immense periods of time And tremors are on nearly all the time Suppose that a seismograph could be placed in the center of each square mile of the earth s land surface and that each instrument connected with one central seismograph Then the latter would be agitated almost incessantly The earth has no rest And this is true of its inhabitants The centrifugal tendency of the earth in its flight reacting against the attraction of the sun is expressed by the words four quintillion tons

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Apropos of our illustration last week of the big California oil gusher it is interesting to note that the United States Geological Survey estimates that there are deposited in the different fields of California 8 500 000 000 barrels of petroleum which is more than one third of the entire amount of oil now stored in the ground of the United States The next largest are the Appalachian field with 5 000 000 000 and the Lima Indiana field with 4 000 000 000 barrels It is estimated that it would take 13 400 000 cars to hold this available oil and that these cars would make up a train 31,000 miles in length

MEASURING INSTRUMENTS OF LONG AGO.—II.*

THE MECHANICAL APPLICATION OF GEOMETRICAL PRINCIPLES

BY WILLIAM E. STARK.

Continued from Supplement No 1795, Page 346

THE GEOMETRIC SQUARE

The instrument most commonly referred to in the sixteenth century authors and which appears to have been in use for at least five hundred years is the geometric square (quadratum geometricum) In its simplest form it consisted of a square frame two sides of which were marked with scales of equal parts the number of divisions being usually twelve or some multiple of twelve These scales referring apparently to the measurement of altitudes by shadows were called umbra recta and umbra versa At the corner of the square opposite the intersection of the scales was pivoted a sighting arm or alidade (Fig XVIII) In the simplest problem that of measuring the height of a tower one edge of the square was held vertically and the alidade was aimed at the top of the tower The reading where the edge of the alidade cut across the scale was then taken If the reading was on the umbra recta the height of the tower was less than its distance from the observer If on the umbra versa it was greater

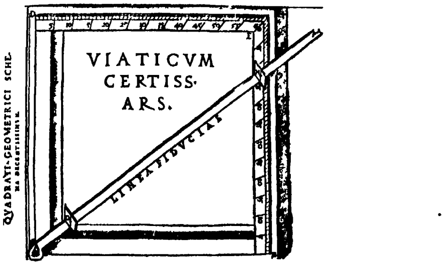

Fig XVIII—GEOMETRIC SQUARE

From Finaeus 8 note under Fig XI

In the first case assuming the reading to be five and the number of divisions on the scale twelve the height of the tower was five twelfths of its distance, in the other with the same reading it was twelve-fifths of the distance

A quadrant was sometimes placed within the square for measuring angular altitudes and a plumb line was often attached to one edge Some forms had supporting staffs to which they could be fastened in either a horizontal or vertical position The early instruments were made of wood and were three or four feet square but the later ones were of metal The one belonging to Prof Smith (Fig XIX) dating from about 1600 is made of brass and is about twelve inches square Umbra versa and umbra recta scales were often engraved on astrolabes Chaucer in his treatise on the Astrolabe 1390 describes this feature and explains how to solve several problems by means of it

In another common form of the instrument for use in measuring altitudes the square was inscribed in a quadrant (Fig XXII) Instead of an alidade the quadrant had sights attached to one of the radial sides and the reading was taken under a plumb line which hung from the center

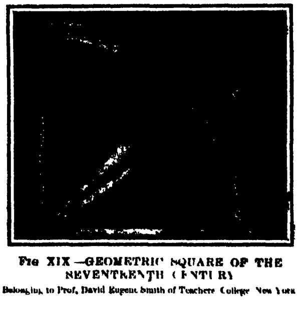

Fig XIX—GEOMETRIC SQUARE OF THE SEVENTEENTH CENTURY

Belonging to Prof. David Eugene Smith of Teachers College New York

An interesting modification of the quadrant form of the geometric square (Fig XXIII) was devised for the purpose of reducing a distance measured on a slope to a horizontal measurement Near the center of the quadrant *BAC* which is made of wood or metal a graduated straight edge is pivoted The line *kM* which represents the position of the straight edge when *AB* is vertical is graduated in the same way as the straight edge and a series of semicircles is drawn through the points of division as shown in the diagram In use (Fig XXIV) the side *AC* is held parallel to the slope and the straight edge is allowed to take its natural position Suppose the distance on the slope to be 70 feet. Then the reading of the straight edge where it cuts the semicircle which passes through 70 on scale *KM* gives the horizontal distance If the slope distance is too long to be applied directly to the scale *KM* it is divided by two or three for example, and the reading is multiplied by the same number

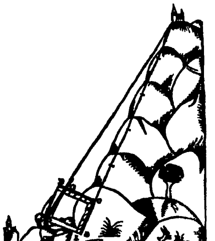

Fig XX—USE OF GEOMETRIC SQUARE

From Finaeus.

A general lack of skill in computation is implied in the proud claims of many authors that with their instruments all calculation is avoided Belli's square (Fig XXV) was solid and ruled like a checker board Holes were bored at the graduation marks along two sides of the square into which the pivot of the alidade could be thrust With this device it was possible to make one side of the triangle formed on the instrument correspond in length to the base line, and so to read the required distance directly

The most interesting problem solved by means of the square was that of finding the length of a line neither end of which is accessible (Fig XXVI) Supposing the required distance to be the height of a tower two observations were taken from points on the same level and in line with the tower, and the distance between the points of observation measured The result was then calculated by the following rule If both readings fall on the *umbra recta*, multiply the distance between the two stations by twelve and divide the product by the difference between the two readings If both readings fall on the *umbra versa* divide twelve by each reading in turn and take the difference of the quotients Divide the distance between stations by this difference If one reading fell on the *umbra recta* and the other on the *umbra versa* it was necessary to reduce one reading to its equivalent on the other scale before making the calculation according to the rules Here is an opportunity for a good algebraic problem Pupils may verify the correctness of the foregoing rules by stating a pair of simultaneous equations and getting an expression for the height of the tower in terms of the three measurements

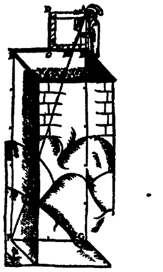

Fig XXI—USE OF GEOMETRIC SQUARE IN MEASURING DEPTH OF WELL

From Finaeus

A few of the additional problems mentioned by Finaeus in connection with the geometric square are (1) To measure a vertical distance from a higher elevation (2) to measure a distance on a slope, (3) to measure the depth of a well

THE CROSS STAFF

The cross staff *baculus* called also the Jacob staff, in its simplest form was a rod of rectangular cross section about four feet long with a short cross-piece having a square hole in the middle This hole fitted the rod snugly enough to keep the crosspiece at right angles to the rod but not too tightly to prevent its position being changed

The staff was marked off into sections equal in length to the crosspiece

The instrument was used for measuring dimensions of inaccessible objects such as a fort (Fig XXVII) The crosspiece was first placed at one of the division marks of the staff The observer then took a position opposite the middle of the line which he wished to measure and moved forward or backward until when one end of the staff was placed at the eye, the crosspiece just covered the object The crosspiece was then moved to the next division of the staff, and the observer took such a position that the object was again exactly covered The required distance was

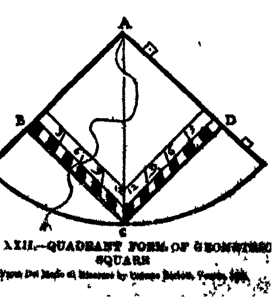

Fig. XXII—QUADRANT FORM OF GEOMETRIC SQUARE

From Del Modo di [illegible] by [illegible], Venice, [illegible] obtained by measuring from one point of observation to the other.

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* School Science and Mathematics

Fiammelli* says that Finaeus and Bartoli who speak highly of the *baculus* were mathematical theorists and not practical workmen and that their claims

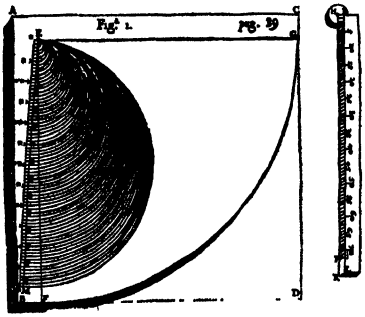

FIG XXIII.—INSTRUMENT FOR REDUCING MEASUREMENTS ON A SLOPE TO HORIZONTAL DISTANCES

From Trattat[illegible] Cometria by Ludov[illegible] Third Edition V[illegible]

are not justified. He says that it is often impossible to get observations from points as far apart as the length of the required line and gives a general rule for calculating the desired dimension from two observations and the distance between them.

His rule is to multiply the distance between stations by the fractional part of a cross-bar length between the two settings of the cross-bar. To obtain the latter

FIG XXIV

From Perini See Fig XXIII

factor with accuracy he proposes that the principal spaces on the staff be each divided into one hundred parts.

The verification of Fiammelli's rule and of the special relation referred to by Finaeus are valuable students' exercises.

SECTOR COMPASSES

The sector compasses or sector (*compas de proportion*) combined in a single small instrument the means of solving a great variety of problems in arithmetical and geometrical proportion. It was used by architects, surveyors, military engineers and practical mathematicians generally. It was made in various sizes and some examples were of beautiful workmanship. The earliest description of the sector which I have found is in Bettinus Apiaria† 1645 although it is said to have been invented nearly a century earlier.‡

FIG XXV.—GEOMETRIC SQUARE DESIGNED TO AVOID CALCULATION

From Belli See note under Fig XII.

Though still listed in the catalogues of dealers, this device, which maintained its utility for two hundred years, appears to have been almost completely forgotten.

The instrument consisted of two metal rules usually about six inches long joined by a hinge like the common two-foot rule (Fig XXVIII). From the center of the pivot six pairs of lines radiated three on each face of the instrument. The lines were graduated, the two members of each pair one on each rule being in symmetrical positions and marked with identical divisions (Fig XXIX).

On one face of the sector of the eighteenth century were the lines of equal parts, the lines of squares and the lines of polygons. On the other the lines of chords, the lines of cubes and the lines of metals. On the first face also there was usually a scale giving the caliber of cannon corresponding to the weight of the ball and in a corresponding position on the other

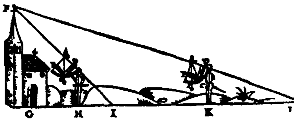

FIG XXVI.—MEASURING THE HEIGHT OF A TOWER WHOSE BASE IS INACCESSIBLE

From Finaeus

face a scale of diameters of bullets of given weight. Lines of sines, of tangents and of secants were added at a later period.

In the instrument as described by Bion each line of equal parts was divided into two hundred segments and numbered beginning at the hinge. To divide a line into any number of equal parts, for example seven, take the length of the line on a pair of dividers and placing one point of the dividers on the point marked 70 or 140 on one line of equal parts open the compass until the other point of the dividers touches the same number on the other line of equal parts. Then the distance from one 10 (that is from the point marked 10 on one of the lines of equal parts) to the other is one-seventh of the line from 20 to 20 two-sevenths, and so on.

The foregoing problem will suggest at once the utility of the instrument in drawing to a scale or in measuring distances taken from a map whose scale is given. The only other problem for the line of equal parts which I shall mention is that of finding a straight line of the same length as the circumference of a given circle. To do this take the given diameter in a pair of dividers and set the compasses so that the dividers span from 50 to 50. The distance from 157 to 157 is then the length of the required line.

The line of squares is simply a scale of square roots, that is the distance from the pivot to any point on the scale is proportional to the square root of the number standing opposite the point. To find the side of a polygon whose area is three-fifths of that of a

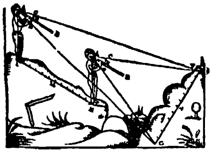

FIG XXVII.—THE CROSS-STAFF IN USE

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given similar polygon set the compasses so that the distance from 50 to 50 on the line of squares is equal to the side of the given polygon. Then the distance from 30 to 30 is the required line. Other problems to be solved by the line of squares are (1) to determine the ratio of areas of two given similar polygons and (2) to construct a polygon similar to two given polygons and equal to their sum or their difference.

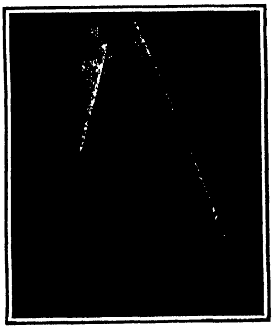

FIG XXVIII.—SECTOR COMPASSES 18TH CENTURY

Belonging to Prof David Eugene Smith of Teachers College New York

The method of laying out the line of squares is a good application of the Pythagorean proposition (Fig XXIX). A line *KI* is drawn equal in length to the proposed line of squares. This is divided into eight equal parts and the points of division numbered 1 4 9 16 2 6 49. The end of the line is numbered 64. At *K* the zero end of the line a perpendicular *KM* is erected equal to one of the eight parts just referred to. Then the distance *M*1 is taken in the dividers and laid off on the line from K. The point found is numbered 2. The distance *B*2 is then laid off from *K* giving a point which is numbered 3. In general the distance from *K* to any point is equal to the distance from *M* to the preceding point.

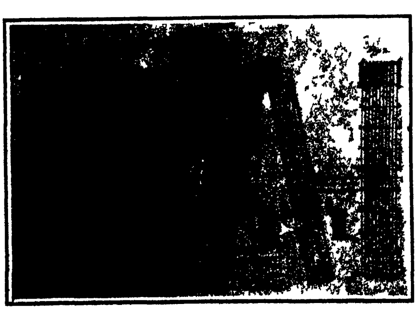

FIG XXIX.—SECTOR COMPASSES

From Bion

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* La Riga Matematica di [illegible], Francesco Fiammelli, Florentine Mathematician, Rome.

† Apiaria Universae Philosophiae Mathematicae. Marius Bettinus of Bologna and the Society of Jesus. Bologna, 1645.

‡ [illegible] Encyclopaedia. Article on Sector.

The line of polygons gives the relative lengths of the sides of regular polygons inscribed in the same circle As an example of the use of this line let it be required to inscribe a regular polygon of seven sides in a given circle Open the sector so that the distance from the points marked 6 on the line of polygons is equal to the radius of the given circle Then the distance from 7 to 7 is the length of the required side and may be stepped off on the circumference with the dividers Other problems for the line of polygons are (1) to describe a given regular polygon on a given side and (2) to divide a given line in extreme and mean ratio

On the line of chords (Fig XXIX) the distance from the pivot to any point is the chord subtending a central angle measured by the number of degrees marked opposite the point the whole length of the line being the diameter or the chord of 180 deg To open the compass so that the lines of chords make any desired angle for example 7 deg take in the dividers the distance from the pivot to point 57 on the line of chords and open the compasses until this distance spans from 60 to 60 Other problems are (1) to lay out any desired angle (2) to measure a given angle and (3) to take on the circumference of a given circle an arc of any required number of degrees

The line of cubes is a scale of cube roots corresponding to the scale of square roots on the other face of the compasses To find the ratio of volume of two similar solids set the compasses so that the distance from 10 to 10 on the lines of cubes is equal to some dimension of one of the solids Then take the corresponding dimension of the other solid in the dividers and find the reading on the lines of cubes indicated by this distance, spanned from one line to the other The ratio of the reading to 10, of course gives the desired ratio The line of solids was used to make a scale showing the relation of the weight of a bullet to the caliber of the gun which would fire it, also to divide a gage for measuring the capacity of casks

The distances from the pivot to the graduation marks on the line of metals are proportional to the dimensions of similar solids of equal weight made of gold lead silver brass iron and tin Among the problems solved by use of the line of metals are (1) to find the diameter of a ball of the same weight as a given ball but of different metal (2) to find the relative weight of the various metals (3) to find the weight of a body of the same size and shape as a given body of another metal

(To be concluded)

REMARKABLE COMETS.—II.*

COMETS OTHER THAN HALLEY'S.

Concluded from Supplement No 1795, page 342

Few comets excited greater sensation by their sudden appearance above the horizon than the great comet of 1861 (No II of that year) It was discovered by J Tebbutt an amateur astronomer at Windsor N S W on May 13th previous to its perihelion passage which took place on June 11th Passing from the Southern Hemisphere into the Northern it became visible in this country on June 29th though it was not generally seen until the following evening It is so rare for the inhabitants of the British Islands to have a big comet all their own as it were that in this case the multitude of observers and observations was so great that selection is difficult

A good all round description was that given by Sir John Herschel who observed the comet at his house Collingwood Hawkhurst Kent He says

The comet which was first noticed here on Saturday night June 29th by a resident in the village of Hawkhurst (who informs me that his attention was drawn to it by its being taken by some of his family for the moon rising) became conspicuously visible on the 30th when I first observed it It then far exceeded in brightness any comet I have before observed those of 1811 and the recent splendid one of 1858 not excepted Its total light certainly far surpassed that of any fixed star or planet except perhaps Venus at its maximum The tail extended from its then position about 8 deg or 10 deg above the horizon to within 10 deg or 12 deg of the Pole star and was therefore about 30 deg in length Its greatest breadth which diminished rapidly in receding from the head might be about deg Viewed through a good achromatic by Peter Dollond of ¾ inches aperture and 4 foot focal length it exhibited a very condensed central light which might fairly be called a nucleus but in its low situation at that time no other physical peculiarities could be observed On the 1st instant it was seen early in the evening but before I could bring a telescope to bear on it clouds intervened and continued till morning twilight On the 2nd (Tuesday) being now much better situated for observation and the night being clear its appearance at midnight was truly magnificent The tail considerably diminished in breadth had shot out to an extravagant length extending from the place of the head above α of the Great Bear at least to π and ι Herculis that is to say about 72 deg and perhaps somewhat further It exhibited no bifurcation or lateral offsets and no curvature like that of the comet of 1858 but appeared rather as a narrow prolongation of the northern side of the broader portion near the comet than as a thinning off of the latter along a central axis thus imparting an unsymmetrical aspect to the whole phenomenon

Viewed through a 7 foot Newtonian reflector of 6 inches aperture the nucleus was uncommonly vivid and was concentrated in a dense pellet of not more than 4 sec or 5 sec in diameter (about 315 miles) It was round and so very little *woolly* that it might *almost* have been taken for a small planet seen through a dense fog still so far from *sharp* definition as to preclude any idea of its being a solid body No sparkling or star light point could however be discerned in *its* center with the power used (96) nor any separation by a darker interval between the nucleus and the cometic envelope The gradation of light though rapid was continuous Neither on this occasion was there any *unequivocal* appearance of that sort of fan or sector of light which has been noticed on so many former ones

'The appearance of the 3rd was nearly similar but on the 4th the fan though feebly was yet certainly perceived and on the th was very distinctly visible It consisted however not in any vividly radiating jet of light from the nucleus of any well defined form but in a crescent shaped cap formed by a very delicately graduated condensation of the light on the side toward the sun connected with the nucleus and what may be termed the *coma* (or spherical haze immediately surrounding it) by an equally delicate gradation of light very evidently superior in intensity to that on the opposite side Having no micrometer at hand I could only estimate the distance of the brightest portion of this crescent from the nucleus at about 7 min or 8 min corresponding at the distance of the comet at that time to about 37 000 miles On the 4th (Thursday) the tail (preserving all the characters already described on the 2nd) passed through α Draconis and ι Herculis nearly over π and ε Herculis and was traceable though with difficulty almost up to α Ophiuchi giving a total length of 80 deg The northern edge of the tail from α Draconis onward was perfectly straight—not in the least curved—which of course must be understood with reference to a great circle of the heavens

Viewed on the 7th through a doubly refracting prism well achromatized no certain indication of polarization in the light of the nucleus and head of the comet could be perceived The two images were distinctly separated and revolved round each other with the rotation of the prism without at least any marked alternating difference of brightness Calculating on Mr Hind's data the angle between the sun and the earth and the comet must then have been 104 deg giving an angle of incidence equal to 52 deg and obliquity 38 deg for a ray supposed to reach the eye *after a single* reflection from the cometic matter This is not an angle unfavorable to polarization but the reverse At 68 deg of elongation from the sun (which was that of the comet on the occasion in question) the blue light of the sky is very considerably polarized The constitution of the comet therefore is analogous to that of a cloud the light reflected from which as is well known at that (or any other) angle of elongation from the sun exhibits no signs of polarity

A very interesting point was raised by Hind and developed so to speak by F J Lowe the well known meteorologist Hind stated that he thought it not only possible but even probable that in the course of Sunday June 30th the earth passed through the tail of the comet at a distance of perhaps two thirds of its length from the nucleus The head of the comet was in the ecliptic at 6 P M on June 28th at a distance from the earth's orbit of about 13 000 000 miles on the inside its heliocentric longitude (its longitude seen from the center of the sun) being 279 deg The earth at that moment was rather more than 2 deg behind that point but would arrive there soon after 10 P M on June 30th The tail of a comet is seldom an exact prolongation of the radius vector or imaginary line joining the nucleus with the sun, toward its extremity a tail is almost invariably curved or in other words the matter composing it lags behind what would be its position if it traveled with the same speed as the nucleus Now judging from the amount of curvature on June 30th and the direction of the comet's motion Hind thought that the earth very probably encountered the tail in the early part of that day, or at any rate that it was certainly in a region which had been swept over by cometary matter a short time previously He added that on the evening of June 30th there was a peculiar phosphorescence or illumination of the sky which he attributed at the time to an auroral glare It was remarked by other persons as something unusual and it seems scarcely open to doubt that the earth's proximity to the comet had something to do with it Lowe confirmed Hind's statement of the sky having a peculiar appearance on the evening of June 30th He says that the sky had a yellow auroral glare like look and that the sun though shining gave but a feeble light The comet was plainly visible during sunshine at 7 45 P M In confirmation of the statement that there was something unusual and indescribable happening Lowe adds that in his parish church the vicar had the pulpit candles lighted at 7 o'clock which proves that some sensation of darkness was felt even while the sun was shining Though unaware at the time that the comet's tail was enveloping the earth he was so struck by the singularity of what he saw that he made the following entry in his day book A singular yellow phosphorescent glare very like diffused Aurora Borealis, yet being daylight such Aurora could scarcely be noticeable The comet itself he states had a much more hazy appearance than on any subsequent evening

De La Rue attempted to photograph the comet but it left no impressions on two collodion plates although neighboring stars did impress themselves on the plates

No fewer than eleven envelopes were seen to spring from the head of this comet between July 2nd when portions of three were in sight and July 19th a new one rising at regular intervals every second day And their evolution and dispersion took place with much greater rapidity than was the case with Donati's comet in 1858 each envelope taking but two or three days to go through its various changes instead of two or three weeks

On the question of the polarization of the light of the comet Secchi said

The most interesting fact that I observed was this the polarization of the light of the comet's tail and of the rays near the nucleus was very strong and one could even distinguish it with the band polariscope but the nucleus presented no trace of polarization not even Arago's polariscope with double colored image On the contrary on the evenings of July 3rd and following days the nucleus presented decided indications in spite of its extreme smallness which on the evening of July 7th was found to be hardly 1 second

I think this a fact of great importance for it seems that the nucleus on the former days shone by its own light, perhaps by reason of the incandescence to which it had been brought by its close proximity to the sun

'During the following days the tail has been constantly diminishing but it is remarkable that it has always passed near to α Herculis and that it reached to the Milky Way up to July 6th It would seem that the two tails were nearly independent, and that on July 5th the length and straightness had gone off from the large one and that this bent itself to the southern side Last night (July 7th) the long train was hardly perceptible The light was polarised in the plane of the tail

Observations on the polarization of the light of the comet were also made by Poey at Passy near Paris He found that "the plane of polarization seemed to pass sensibly perpendicular to the axis of the tail" Poey had in 1858 observed Donati's comet for polarization and found that its light was polarized in a plane passing through the sun, the comet and the observer

The comet of 1862 (III) though not one of first-class magnitude or brilliancy, was nevertheless a very interesting object on account of the fact that a jet of light, frequently altering in form, was observed for a long time to emanate from its nucleus Jets of light shooting forth under such circumstances are not uncommon, as we have already seen but in the case of this particular comet there seemed an unceasing supply thrown out from the nucleus without any material deterioration of the luminosity of the source of supply This comet had a tail which on August 27th was 20 deg long

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* The Story of the Comets Simply Told for General Readers By George F Chambers F R A S Oxford at the Clarendon Press 1909

The comet of 1874 (III), discovered by Coggia at Marseilles was one of considerable interest The southerly motion of the comet was so rapid that on July 14th the presence of twilight greatly interfered with the visibility The following description is from the pen of F Brodie

The head of the comet presented the great peculiarity of having two eccentric envelopes in addition to the ordinary bright envelope immediately surrounding the nucleus The first envelope was a bright and sharply defined semicircle surrounding the nucleus the two eccentric envelopes were nearly as bright and also very sharply defined also semicircular having their centers placed (about) on the edge of the first envelope and intersecting each other The second central envelope just embraced both these eccentric envelopes and was about half the width of the nebulous head of the comet Between this second envelope and the ill defined outline of the head there were faintly marked outlines of other concentric envelopes The nucleus which according to Hind was 4 000 miles in diameter appeared to be somewhat flattened on the side opposite to the sun From this side also the head of the comet divided itself into two distinct parts forming the commencement of the tail for some distance the bifurcation was remarkably sharply defined suggesting an intense repulsive force acting upon the nucleus of the comet and the space inclosed between this bifurcation was strikingly free from nebulous matter until at some little distance away from the nucleus the sharp definition faded into the general nebulosity of the tail

The following remarks on this comet are by two French observers MM Wolf and Rayet

After having maintained for many days a great sameness of form on June 22nd a series of changes in the shape of the head of the comet commenced On that day the comet viewed with a Foucault telescope of 40 centimeters (15¾ inches) appeared to be inclosed in the interior of a very elongated parabola Starting from the nucleus which was placed as it were at the focus of the curve, the brightness decreased gradually toward the summit but the interior of the parabola the diminution of the brightness was sudden, and the boundary line exhibited another parabola a little more open than the first and having at its own summit the brilliant nucleus itself The outline of the parabola which passed through the nucleus was prolonged so as to form the lateral boundaries of the tail, the edges of which were well defined and were much brighter than the interior parts This tail had then the appearance of a luminous envelope hollow in the inside The nucleus was always very sharp On July 1st the general form of the comet remained the same it appeared always to possess a parabolic outline at its exterior edge The nucleus however jutted out into the interior of the second parabola and the opposite margins of the tail were not strictly symmetrical The west side that is to say the side which had the greatest R A was very sensibly brighter than the other From July 5th, the want of symmetry spoken of above became more and more marked and near the head the decrease of the brightness became less regular On July 7th, the contrast between the two branches was striking the western branch of the tail being about twice as bright as the eastern At the same time the nucleus appeared to be becoming diffused and it seemed to fade away in the direction of the head of the comet although still sharply defined on the side nearest the tail one could not fail to remark its resemblance to an open fan Our last observation of the comet was made on July 14th at 9 30 P M important changes in the aspect of the head had manifested themselves The fan of light had disappeared on the west side, and was replaced by a long spur of light which was traceable for a considerable distance across the head; on the west side the remnant of the fan terminated abruptly, and the boundary line there made but a small angle with the main axis of the comet On this same occasion two rays of light were visible—two jets as they might be deemed—thrown forward, the one to the right and the other to the left, these luminous rays seemed to have their origin at the edge of the fan of which they formed a sort of prolongation The ray which pointed toward the east projected well forward, and being bent round toward the tail soon reached the preceding edge of the comet; it was faint and hardly surpassed the nebulosity in brilliancy The ray projected toward the west was much more brilliant, and was similarly bent round toward the tail, which it assisted in providing with a bright exterior edge"

The comet was nearest to the earth on July 21st, when its distance was less than it had been on July 17th by 9 000 000 miles During this week the comet's tail remained visible stretching toward the north for some hours after the nucleus had descended below the horizon It would have been an exceedingly striking object all this week if it could have been seen as a whole but it had got too close to the sun The tail reached a length of 43 deg on July 19th but on the evening when Brodie's sketch was made it was no more than 20 deg Coggia's comet undoubtedly revolves in an elliptic orbit but there is great discordance in the values given of the period Seyboth's period is 5 711 years but Geelmuyden put it as high as 10 445 years

The comet of 1880 (I) generally called the Great Southern Comet of 1880 was noticed by several persons in Australia South America and South Africa on February 1st but its cometary nature seems not to have been recognized till the following night Gould at Cordoba described the tail as 40 deg long and from 1½ deg to 2½ deg broad but at no time was the nucleus very bright The elements closely resemble those of the great comet of 1843 also celebrated as we have seen for the length of its tail but the identity of the two bodies has not yet been satisfactorily established This comet was unfavorably placed for observation and was only seen for two or three weeks

The comet of 1882 (II) was in some respects one of the most remarkable seen by the present generation of astronomers It was conspicuously visible to the naked eye for some weeks in September and altogether remained in sight for the long period of nine months The special peculiarities which seem to differentiate this comet from all others which have been exhaustively scrutinized either before or since were that the head underwent changes in the nature of disruptions that the tail may have been tubular that the extremity of the tail was not only bifid (or split) but that it was entirely unsymmetrical considered in relation to the greater part of the tail and that on one occasion the comet seems to have thrown off a mass of matter which became and for several days was observed as a distinct comet The changes which took place in the nucleus and head were noted and described by many observers Prince wrote

October 17th—I could notice however that there was a decided change in the appearance of the nucleus Instead of being of an oval shape it had become a long flickering column of light in the direction of the tail

October 20th—I noticed however at once that a still further change had occurred in the nucleus since the 13th which amounted in fact to its disruption into at least three portions

"October 23—The disruption of the nucleus which I had noticed on the 20th was now fully apparent The nucleus proper had become quite linear having upon it the four distinct point of condensation The linear nucleus with these points of condensation upon it was surrounded by a distinct oblong coma which was rounded off at the lower extremity while the upper portion following the direction of the tail terminated more decidedly in a point Mr G J Symons F R S was with me in the observatory and his impression was that there were *five* points of condensation and he remarked that the nucleus was like a string of beads At intervals I thought there *was* another point of light but I could not absolutely satisfy myself of its objective existence Both Mr Symons and myself particularly noticed the frequent flickering of the light of the nucleus which was quite apparent both to the naked eye and in the telescope

J F J Schmidt published a sketch of the nucleus which is not unlike Prince's and having seen Prince's he refers to it as a good representation of what he had seen himself He noticed a vibratory motion of the fan

The suggestion that the comet's tail was tubular in form is due to Tempel who brought out the idea in some striking sketches which he sent to the Royal Astronomical Society accompanied for the sake of comparison, by a drawing of the appearance of two hollow glass cylinders as seen in the focus of an eye piece

The peculiar shape of the tip of this comet's tail was mentioned by most observers This feature though rare as regards the comets of the last half century may be conceived to be the shape meant by old writers when they speak (as they often do) of having seen a comet resembling in form "a Turkish scymitar"

The most noteworthy physical peculiarity of the comet of 1882 was its throwing off a mass of matter which became a satellite comet, as recorded by Schmidt at Athens and by Barnard and Brooks in America Perhaps it is going too far to speak quite as definitely as this but the fact is clear that Schmidt saw on October 9th and on two or three later days a nebulous mass in the neighborhood of the comet which calculation indicated to be cometary matter moving round the sun in an orbit considerably resembling the orbit of the comet. Brooks's observation made on October 21st was that he saw a nebulous mass on the opposite side of the comet to Schmidt's mass With the evidence before us of what happened in 1846 in the case of Biela's comet it is impossible not to draw the inference that the nebulous mass (or masses) was, or had been a part of the comet itself and this theory becomes much strengthened when read in the light of the disruptive changes which the nucleus underwent as already mentioned

Gen Willis observed the comet at sea 70 miles east of Gibraltar on October 19th at 7 A M with the air extremely clear and calm He says that in appearance the comet was so extremely delicate light and airy that it would be almost impossible to depict it on paper

Holden contributed some information bearing on the question of disruption With reference to the compound nucleus of the comet on October 13th and October 17th it may be remarked that two of the nuclei seen by Holden were seen by Cruls at Rio de Janeiro at the intermediate date of October 1 th Cruls found these nuclei to resemble stars of the seventh and eighth magnitudes respectively the distance between them being 6¾ sec He was led to regard the peculiar appearance of the tail as being really due to two tails one superposed upon the other each connected with a nucleus of its own independent of the other

Not only did this comet puzzle astronomers very much in the matter of its physical appearance but its orbit has also been a source of great searchings of heart The elements closely resemble those of the comet of 1880 (I) This in turn was considered to be a comet moving in an elliptic orbit with a period of about 7 years and to be in fact a return of the celebrated comet of 1843 It still remains a moot point what interpretation is to be put upon these orbital resemblances the fact of which cannot be questioned And there is the further complication that since the advent of the comet of 1882 another one has presented itself namely the comet of 1887 (I) whose elements also bear a strong resemblance to those of three comets just mentioned The suggestion has been made that these four comets all of them large ones (and perhaps another also) had a common origin but that by some process of disintegration the original mass yielded four or more fragments which pursuing paths only slightly different have arrived at perihelion at different epochs It will be seen at on that this is a very speculative question

The comet of 1887 was seen only in the Southern Hemisphere It seems to have been first seen in South Africa by a farmer and fisherman at Blauwberg near Cape Town on January 18th Finlay who first saw it on January 22nd describes it as a pale narrow ribbon of light quite straight and of nearly uniform brightness throughout its length There was no head or condensation of any kind visible near the end the light simply fading away to nothing The tail was described by Todd at Adelaide Australia as a narrow nebulous streak but the remarkable thing is that the tail was as much as 30 deg or more long according to several observers To both Finlay and Todd this comet recalled the great Southern comet of 1880 as regards its appearance and Finlay was so impressed by the resemblance that he took steps to investigate its orbit and strange to say found that the resemblance even extended to that detail His conclusion was thus expressed These elements though of course rough prove conclusively that the comet belongs to the family of Sun grazers of which 1843 (I), 1880 (I) and 1881 (II) are members

Sawerthal's comet of 1888 (I) exhibited on March 27th a triple nucleus not unlike that of the great comet of 1882 This comet had a tail which on April 11th was 5 deg long It revolves in an elliptic orbit to which a period of 1 615 years has been assigned The configuration of the head was very remarkable and unusual

The comet of 1901 (I) discovered at Paysandu in South America on April 12th but scarcely reached from any observatory in the Northern Hemisphere except the Lick in California has some claim to be called remarkable Its main tail which did not exceed 10 deg in length, was preceded by a faint tail fully 70 deg long which branched out from the main tail, making with it an angle of about 40 deg or nearly half a right angle On April 24th although in twilight the nucleus was very bright and distinctly of a yellow tinge as seen by Innes at the Cape Observatory On May 12th though the comet had become intrinsically much fainter it was still a magnificent object and in between the two tails spoken of above two other slender tails were visible The spectrum appeared to be continuous The comet was visible for about six weeks but bad weather both at the Cape and in Australia and the comet's inconvenient position with respect to the sun interfered very much to prevent a good series of observations On May 2nd the nucleus is said to have rivaled Sirius in luster and to have been distinctly elliptical in shape Eddie, at Naauwpoort in South Africa, speaks of the matter composing the long tail as being "striated"

SCIENCE NOTES

According to the Gummi Zeitung Dr Karl Harries professor of chemistry at the Kiel University in an address delivered before the Engineers and Architects Society of Vienna stated that samples of artificial rubber had been submitted to him by a leading German chemical works and that shortly afterward he had succeeded in producing artificial rubber After interminable fruitless attempts he succeeded in transforming isopren a constituent of rubber which had previously been synthetically produced into rubber Prof Harries exhibited samples of the artificial rubber which was in every respect entirely similar to the natural rubber

In the process of separating the rare earths it is necessary to determine from time to time the degree to which the separation has been carried If exact quantitative results are desired it is advantageous to make use of some property which the various earths possess in widely different degrees This is the case with the magnetic permeability The magnetic balance of Curie and Cheneveau serves admirably for making these measurements on either solutions or dry salts By the application of this method to the intermediate fractional parts obtained in the separation of two nearly related earths it is possible to detect the presence of other elements which cannot be detected with the spectroscope

Albert Brun, in the Revue des Sciences cites experiments and observations made by himself and others to prove that contrary to the prevailing opinion water does not play the most important part in volcanic phenomena and that eruptions and other manifestations of volcanic activity are not produced by the sudden generation of great volumes of water vapor The fusing points of the lavas of different volcanoes range from 1000 to [illegible] deg F When lava is melted it evolves gas so rapidly that it expands to at least twenty times the volume which it occupied in the solid state This experiment can be repeated several times before all of the gas which escapes with difficulty from the viscous liquid is expelled The gas is composed chiefly of chlorine hydrochloric acid sulphur dioxide carbon dioxide and carbon monoxide One eighth of the volume consists of other gases Ammonium chloride formed during the eruption is always present in small quantities (8 to 17 parts by weight in one million parts of lava) From the values of the covolumes of these gases it is calculated that their pressure at the moment of disengagement may amount to [illegible] tons per square inch This enormous pressure is equal to the weight of a column of basalt more than sixty miles in height and is amply sufficient to move mountains All of these gases are dry unless they have become mixed with air The disengagement of chlorine alone is sufficient to account for the eruption The gases are produced by the action of four classes of compounds upon each other and upon the lava These compounds are hydrocarbons nitride of silicon chlorated silicates and silicates of iron Brun explains the frequent occurrence of geysers suffioni aqueous fumaroles and other evidences of the presence of water in volcanic eruptions as a subsidiary effect due to surface and underground water After the water of the upper strata has thus been eliminated i e the moment of eruption the true volcanic phenomenon appears in purity and the lava ejected is absolutely dry The temperature required for complete dehydration varies with the lava i e with the volcano

ELECTRICAL NOTES.

Some interesting observations on the effects of electricity on plant growth are published in the Journal of the Bath and West and Southern Counties Society It is held that such fruits as strawberries are most suitable for treatment since there seems to be some fear of over stimulation in the case of fruit trees and wheat is said to be less responsive, while legumes are adversely affected Actual increases of production recorded are 39 per cent in wheat, 65 per cent in roots, and 80 per cent in strawberries It is suggested that the action of electricity is equivalent to that of an extra supply of sunshine but that is surely somewhat of a makeshift theory It might as well be said that sunshine is merely another method of applying the electrical treatment

The February issue of the Journal of the Institution of Electrical Engineers contains a communication made to the Manchester section of the Institution by Mr J W Warr on the electric ignition of internal combustion engines Descriptions of the principal methods of electric ignition at present in use are given but the author expresses a decided preference for the high tension method both for stationary engines and for motor cars The simplicity of the means of production of the current for low tension methods is more than compensated by the trouble introduced by the mechanical contact breakers which are then necessary to produce the spark Of the various high tension methods Mr Warr considers that depending directly on a magneto machine to be the most trustworthy

The researches which have been undertaken in the physical laboratory of the Johns Hopkins University with a view to investigating the conditions under which the corona or brush discharge takes place from high voltage transmission conductors above a certain value of voltage have resulted in the general conclusion that the air is ionized at different values of electric intensity for different sizes of wire It would also appear states a contemporary that while the point of breakdown or ionization does not occur at a definite value of electric intensity observations on four sizes of conductor indicate that if there is any effect of moisture in the air the values of the voltage at which corona is formed are not influenced by more than 2 per cent This applies to a range of moisture content from air which is quite dry up to the saturated condition The influence of temperature is being studied and the preliminary results indicate that for a range of from zero to 40 deg C there is a lowering of about 3 per cent in the value of the critical voltage

There has recently been placed in service at Gothenburg Sweden an electric welding equipment fitted on an old barge that can be towed alongside any steamer needing repairs The outfit includes a small marine boiler, with a De Laval turbine working two direct current generators Duplicate cables can reach on board the steamer and to the inside of the boilers if necessary and make it practicable to do repairs in two places at once One end of the barge has a work shop with anvil and vise benches and a full equipment for small repairs The anvil block is a steel slab 10 5 inches wide by 2 5 inches deep supported on two wooden trestles and the negative from the generator is clamped to it the positive being the holder with insulated handle held in the operator's left hand The current passes through the jaws holding the specially prepared rod 3 16 inch in diameter used for welding The pieces to be welded with chamfered edges are secured in position on the anvil block, the rod is put to the point to be welded and slightly withdrawn. The electric arc thus formed quickly melts the end of the rod, causing a drop from it to adhere to the work. This is hammered, and the process repeated A great variety of work can be done, and in butt welding a rate for ⅜ inch plates is about 10 feet an hour

ENGINEERING NOTES.

The destructive effect of a locomotive blast at short range has been observed at the Cottage Farm bridge in Boston which was built in 1896 with a clearance of only 15 feet over the tracks of the Boston and Albany Railroad The floor was supported on hollow-tile arches strung between the webs and flanges of steel I beams the latter being protected by thick lead plate completely inclosing them and receiving the special skew back tiles on their upper surface Within ten years the blast ate entirely through the lower faces of the tiles and cut out pieces of the lead protection so that in many cases they fell to the ground necessitating the complete removal of both lead and tile Another Boston bridge over the Boston and Maine Railway lines has wooden stringers over the up grade track where the locomotives pass under forced blast, these stringers have been corroded to a depth of about ½ inch while over the down grade tracks, where the locomotives do not run under forced draft, no erosion is noticeable In bridges having a clearance of 18 feet above the tracks much less injury from locomotive blast is noted than where only the minimum of 15 feet is provided

Mr G. Gibbs, chief electrical engineer to the Long Island Railway and the Pennsylvania Tunnel and Terminal Railway, has presented a valuable report to the International Railway Congress on the operating costs of the Long Island and West Jersey electric railways The Long Island road is virtually a crowded suburban line, while the West Jersey and Seashore road has runs of twenty five miles without a stop and approximates to an express long-distance service Both lines work with continuous current, but alternating current is generated at the power house similar it may be remarked to the system on the Liverpool Southport Railway Electrification reduced the working costs per car mile by 36 per cent on the Long Island road, and by 8 per cent on the West Jersey These figures indicate that main line electrification is a long way off, and if it does come will probably be due to the existence of a number of electrified zones in the neighborhood of the larger towns which would naturally materially alter the problem of electrification for intervening stretches of route With respect to the particular figures given above, it is important to remember that the saving referred to ignores the extra capital charges due to electrification

According to a contemporary the crucible steel locomotive crank axles of the Swiss Federal Railways have hitherto been grooved in the crank pins to fit projections on the bushes and retain the oil, it having been found that without this precaution, nickel steel axles especially tend to become hot when running. While the grooves answer the purpose for which they were designed they have on the other hand, proved a source of probable danger, a number of these grooved axles having developed surface cracks all of which start from the oil grooves Some of these cracks extended for a length of nearly 12 inches, and measured up to 1⅛ inches deep, with an outward curve toward the crank In considering the choice of material for replacing these cracked axles, comparative impact tests have been made, under the auspices of the Swiss Association for Testing Materials, with nickel steel and crucible steel, greatly to the disadvantage of the latter material which is also far more sensitive to rapid sectional changes to which the formation of surface cracks is probably attributable From the results of these tests the new specification for locomotive crank axle prescribes steel with 5 per cent of nickel, the oil grooves being abolished and the transition curve between the crank pin and arm increased from 12 millimeters to 20 millimeters radius.

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HEREDITY *

By Prof W E Castle Harvard University

The conservation movement now in progress has for its end to preserve for future generations of men the natural resources of the earth But it goes without saying that the movement is useless unless there are to be future generations of men capable of utilizing those resources Thoughtful persons are beginning to wonder whether this is assured Man is the product of two sets of agencies which we summarize in the terms heredity and environment The question has often been asked which of these is the more important but with this we need not concern ourselves Both are indispensable Seed and soil combined assure a harvest, but if either is lacking no harvest can be expected

The public is awakening to the importance of providing mankind with a proper environment through the agencies of sanitation education and good government and this is well This assures a suitable soil in which a crop of healthy human beings may develop But what of the seed? This question has not yet been seriously considered Only in England has it been more than suggested There Francis Galton and his associates in the eugenics movement have started an inquiry as to why it is that the average physical condition of the English nation is declining although more and more attention is constantly being given to improving the environment Likewise in Germany statistics show a steadily declining proportion of the young men fit for military service There is a suspicion in the minds of many that these nations are producing the new generation of citizens chiefly from inferior family and racial stocks If this is so the remedy is obvious, though how easy of application remains to be ascertained Would a farmer expect to have full harvests if each year he saved seed from the poorest yielding plants or could he hope to secure the best results from his herds by selling or butchering the best stock and keeping only the scrubs? Obviously not and no more can the civilized nations maintain their present standards of manhood if they follow a like practice

But before any serious attempt can be made to improve the human race considered as an assemblage of animals possessed of certain desirable physical and intellectual attributes, it is obvious that we must know something about heredity in general and how in particular each of the desired physical and intellectual attributes is produced Considerations such as these lend general interest to the study of heredity a subject which has always been of great practical concern to farmers and of much theoretical interest to scientists It is my purpose to review briefly some of the problems which the study of heredity presents and some of the results obtained from their consideration

Like father like son is a homely proverb which shows how general the recognition is that children resemble their parents Resemblances to grandparents or ancestors even more remote are also of frequent occurrence and it is convenient to use the term heredity as including all such resemblances whether to near or to remote ancestors The phenomenon of heredity is of course not restricted to human society

(Continued on page 370)

FIG 1 —A YOUNG BLACK GUINEA PIG
About three weeks old The ovaries taken from an animal like this were transplanted into the albino shown in Fig 2.

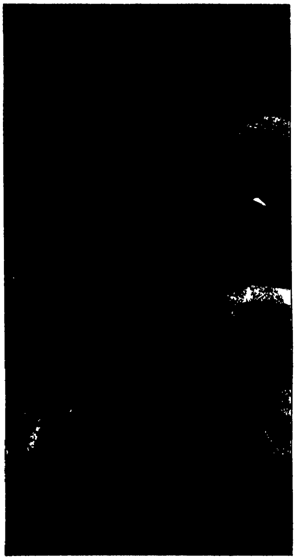

FIG 4 —A GROUP OF THREE YOUNG
Produced by the pair of albinos shown in Figs 2 and 3

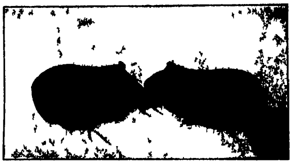

FIG 7 TWO OF THE GROWN UP YOUNG OF A BLACK AND OF AN ALBINO GUINEA PIG

FIG 5 A BLACK FEMALE GUINEA PIG AND HER YOUNG

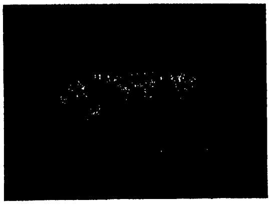

FIG 6 —AN ALBINO GUINEA PIG.
Father of black young like those seen in Fig 5.

FIG 8 —A GROUP OF FOUR YOUNG.
Produced by the animals shown in Fig 7

FIG. 2.—AN ALBINO FEMALE GUINEA-PIG.
Its ovaries were removed and in their place were introduced ovaries from a young black guinea-pig. Compare Fig. 1.

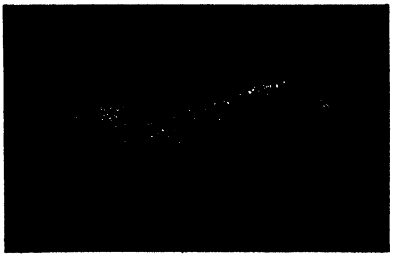

FIG 3.—AN ALBINO MALE GUINEA-PIG.
With which was mated the albino shown in Fig. 2.

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* Lecture delivered before Section F American Association for the Advancement of Science, here reprinted from the Popular Science Monthly

IRISH LINEN.—II.*

SOME FEATURES OF ITS PRODUCTION.

BY SIR WILLIAM CRAWFORD.

Concluded from Supplement No 1796, page 363

Very considerable improvements have taken place in the spinning mills and weaving factories with regard to the conditions under which the operatives work Chief among these is the diminution which has been effected in the amount of dust floating in the air of many of the rooms In this improvement Mr R H Reade chairman of the York Street Flax Spinning Company Limited has been the pioneer The first distinct step in clearing the dust out of the dusty rooms was to localize the exhaust that is to say to collect the dust as near as possible to the point at which it is produced and the principle has been gradually applied beginning with the worst places in the mill The final result might almost be described as a revolution so marked is the improvement in the atmosphere compared with what was looked upon as the normal and inevitable dusty condition of these rooms twenty years ago In the wet spinning rooms close attention to the design and condition of the trough lids coupled with better covering of steam pipes and general exhaust ventilation has greatly reduced the excessive heat and moisture of the rooms and brought the last well within the limits imposed by the Home Office In weaving sheds the better distribution and more extensive application of ventilating and exhaust appliances to satisfy the standard of air purity required by the Home Office has likewise improved the conditions there though to a less marked degree than in the spinning These changes have been introduced by the masters partly on their own initiative and partly at the instigation of the Home Office inspectors and have brought about a distinct and much appreciated improvement in the health of the workers Their trade unions have formally acknowledged the benefits they have derived

Perhaps the improvements in the machines used in the flax industry have not been so rapid or so great as in some other textile industries However there have been some and I may tell you of one that is now coming into extensive use in the hackling of flax This invention due to Mr James G Crawford can be attached to the ordinary hackling machine Formerly four boys were needed to attend to a pair of hackling machines and the work devolving on each of the four boys was extremely arduous so arduous that they remained at it only so long as they were unable to obtain work in another industry By this invention one boy can attend to a pair of hackling machines instead of four boys and the one boy's work is extremely light It thus effects a saving of 75 per cent in wages and in addition the work is better done and practically all the boys can be retained and advanced to apprenticeship in one or other of the trades connected with the flax industry

A recent action of the united body of flax spinners is I think worthy of being recorded to their credit In 1908 during a period of unexampled dullness and depression those masters finding that although they had for some months been running their mills two thirds time in order to lessen production their stocks continued to rise resolved in June of that year still further to reduce production by five hours a week At the same time however they agreed to make no further reduction in the wages of women and young people employed by them And this payment of unearned wages for five hours a week continued for seven months and constituted a gift of about $10 000 I have never heard of a similar act elsewhere In 1906 7 spinners wages had been advanced by 20 per cent Therefore a woman who before 1906 had been earning $2.45 a week of [illegible] hours was temporarily in the time of stress paid $1 96 per week of 52 hours

We now come to the third division viz bleaching In olden days that process could be carried through only in the long days between March and October and it was produced by primitive methods such as boiling the linen in lye made from burned seaweed and then spreading it on the grass field exposed to the effects of sun air and rain and artificial watering After six months or so of this treatment the linen was steeped in buttermilk washed in pure water and finished up The color obtained by these methods was not so white as is now common but the bleached linen retained a high proportion of its natural strength With steam-driven spinning machinery there ensued so great a development of linen manufacture and of the demand for it from foreign markets that a quickening of the process of bleaching became necessary A white color was also demanded and so the use of more chemicals with shorter exposures on the grass became the rule The manner of bleaching that has been carried on for many years past is something like the following 140 webs of yard wide brown linen each one marked on the end with red thread in a way to be identified are stitched together end to end into one piece of say 10 000 yards This is called a pot and in common parlance is spoken of as she It is first passed through a solution of lime into the boiling pot and there boiled eight or ten hours It is then drawn through a tank of water The webs are unsewn each one is bundled separately they are washed in the wash mills with pure water for an hour then steeped in a sour of dilute hydrochloric acid to convert the residue of the lime into a soluble salt washed again in the mills boiled in soda lye which combining with the waxes and fats in the fiber make them into soap and hence removable washed again put on the grass for some days boiled again in lye washed put on the grass rubbed in soap and water boiled in lye washed put on the grass and so on

As soon as it is considered to be sufficiently boiled the whitening process is begun by the use of bleaching powder or Dip in which the cloth is left over night It is washed treated with weak sulphuric acid boiled again with soda lye such processes being repeated until the cloth is found to be of a proper whiteness The webs are once more stitched together and the process of finishing begins The cloth is breadthed passed through a water mangle between rollers which leave just the proper moistures for taking starch then into and through a tank filled with a mixture of blue and starch after which it is passed over heated rollers to dry it The webs are once more unsewn they are put on the beetling beams and beetled for four or five hours, turned on the beams and beetled for another four or five hours and so on till they have had thirty to sixty hours of beetling They are then aired stretched to the full width and calendered

This completes the work of the bleacher the whole occupying eight or twelve weeks If an inquiry is made of a bleacher how is a certain pot coming on or at what stage is it? the reply will probably be She is doing well or She is ready for the blueing A witty or shall I call him a wicked bachelor once suggested that a pot was called she because of its being so hard to bring it to the right point' Linen bleaching is not only a very risky business but it has also been an unprofitable one so the Irish bleachers and the Scotch bleachers have recently been obliged to form an association binding them to regulate their prices and terms by common agreement They are entitled to have a fair living out of their business and may have it without injuring the other sections of the trade

In linen bleaching there is a field for the services of chemical research The present methods carry with them serious risks of damage to the goods A pot may be taken as worth $2 500 and in the North of Ireland seven or eight thousand of such pots are treated each year One may thus form an idea of the magnitude of the risk Here then is a practical object for our scientific men to have before them

The preparation of linen goods for the market is a somewhat elaborate process When the webs are received from the bleaching works they are carefully examined and any defective portions laid aside They are then lapped or folded, and, it may be, ornamented to suit the taste in each market Elaborate folding and costly ornamentation, once so common, are now, however, fast disappearing Great changes have taken place in the methods of selling the products of flax, the tendency being to eliminate the middleman Formerly spinning was the sole business of a firm, whose yarns through one or more intermediaries, reached the weaver, weaving, the sole business of another firm whose goods were sold to the merchants through another intermediary Bleaching was the business of a third the goods were then sold to a merchant-shipper who sold to wholesale houses either at home or abroad, and these sold to the shops. But now two or more of these operations are the business of one firm while some of the largest houses carry through all the operations and by means of travelers, speaking the language of the countries where they go, sell direct to the wholesale houses abroad, and even in some instances to the shops Some firms also have, in the principal using centers branch houses where stock is held, and is sold to the shops as they may require it in the currency of the country

The Companies Act of 1862 and later ones have been availed of largely by the firms engaged in the linen industry The York Street Flax Spinning Company was the first in Belfast to be registered as limited That was done in 1864 Almost every firm of any importance in the linen industry of Ireland is now limited Some of them print their accounts and send them freely to their shareholders, and their shares may be bought by the public Other firms are private limited do not publish their accounts, or allow their shares to be offered to the public

It is an advantage as tending to stability of its business for a firm to be limited in that money put into shares cannot be withdrawn from the company whereas if a partner of a private firm dies his capital may have to be paid out and that may cripple the firm Limited liability also tends to facilitate the extension of a company's plant and operation as it is supposed to have a perpetual life and the shareholders cannot be involved beyond the sum to which they are committed by the shares they hold and further the general public have by means of it access to participation in the profits of the industry

In the linen industry there has been no amalgamation of firms except perhaps the Linen Thread Company But there have been working agreements among masters for the settlement of wages for reducing output and in one instance to maintain a minimum price for yarns This latter agreement among flax spinners come to in 1908 to hold yarns in stock rather than sell them below the price that had been fixed was irksome to some of the spinners but it is now acknowledged by all of them to have been good for themselves and for all connected with the trade

I must not omit to mention the large and prosperous linen thread industry, in which the leading firm is Messrs William Barbour & Sons Lisburn If I do not enter on that interesting subject it is simply because I know too little about it There are also many other branches of the linen industry which time will not allow me to speak of A feature of the industry is the numerous ramifications into which it branches and the comparatively small quantity of each article that has to be manufactured This is indeed one of the safeguards of the position It tends to prevent other countries such as the United States from making such goods themselves

The relations between masters and employees in the linen industry are of a more friendly character than in most other industries In many instances one generation is succeeded by its descendants, and sometimes to the third or fourth generation in the service of the same company Conferences in an amicable spirit have sometimes taken place and arrangements of wages been agreed upon without recourse to strikes which have been rare and always of small dimensions

A rough estimate of the capital employed in the Irish linen trade might be made up as follows 935-000 spindles at an average price of $25 each $23 375,-000, 36 000 power looms at $250, $9 000 000, bleaching printing and finishing works estimated at $2,500,000 These amounts added together would show a total of $34,875 000 in plant alone, in addition to which the stocks of raw material and of goods in process of manufacture and in a finished state would be value for $25,000,000 or $30,000,000 Then there is a further amount of capital employed in giving credit to buyers, and, whether this be in the form of discountable bills or of open accounts capital to the extent of over $10,000 000 is required to do it The grand total of capital employed would thus amount to at least $70,-000,000

One might estimate the amount paid in wages to the operatives as follows 70,382 men, women, and young persons, at an average of $3.12 per week, $11,435,000; bleachers, printers, and finishers $2,020,000; embroiderers, hemstitchers, and warehouse hands, including lappers, ornamenters, and box-makers, $2,000,000; hand-loom weavers, $375,000 Besides all these there are clerks, managers, and other officials whose salaries, would amount to $1,250,000; and if 5 per cent on capital, $3,500,000, be included it would show a grand total of $20,240,000 distributed annually; and three-quarters or more of it is drawn from foreign countries, so [illegible] the greater portion of Irish linen products is sold outside of the United Kingdom.

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* Journal of the Royal Society of Arts

Linen manufacturers ought, of course, to manufacture nothing but linen goods Unfortunately the stress of circumstances forces them to extend their manufactures to unions, that is goods into which enter both linen and cotton yarn In order to meet and satisfy, as far as possible, a craving on the part of buyers for low priced goods, having some appearance of linen, this has long been found necessary The making of unions is justified in the case of fancy dress goods, as undoubtedly cotton takes and holds dye stuffs better than linen, the fiber of it being softer and more penetrable Very beautiful and becoming dress goods are being woven in such unions But into that part of the trade I shall not enter What has been set as my text is *linen*—linen the most ancient of textile fabrics It is hoary with age and with the most sacred associations and charming memories and that it should have to struggle for life now in the fiftieth or perhaps the one hundredth century of its useful existence is at least pathetic Cotton is known to have been in use as a textile for 2 000 years or so The name calico was given because it was first shipped to us from Calicut in India It was in America before Columbus But, as compared with linen, the cotton industry its great and formidable rival is a juvenile It is only within the last 100 or 150 years by the invention of the spinning jenny the power loom, and the fly shuttle that cotton has come really into common use, and that its industry has assumed the gigantic proportions of to-day The linen merchant now meets it as an opponent at every turn and he is so hedged in by it that the linen industry has been barely able to avoid a serious contraction

Among the reasons why cotton is so formidable a competitor of linen the following may be mentioned Although the cost of flax and of raw cotton do not differ very much cotton has a great advantage over flax in the ease and cheapness with which it is manufactured In the first place, the hard and inelastic nature of the flax fiber makes a much more expensive type of machinery necessary for its spinning A cotton mill can be erected complete for about $6 62 a spindle whereas a flax spinning mill would cost from $30 to $40 a spindle Then the great variations produced in any one field of flax necessitate elaborate and costly hackling and sorting in which about 60 per cent of it becomes tow of com low value raising the cost of dressed flax per cent above that of raw flax Cotton, other hand is very uniform in quality and is c carded with little loss of material or of weight elasticity allows of the employment of machiner largely automatic that the num of workers in cotton mill would be about one quarter of those in flax mill of the same number of spindles while at th same time the turn off of a cotton spindle is considerably greater than that of a flax spindle The advantage in favor of cotton does not end with its conversion into yarn for it is more easily woven than linen and finally it is bleached more quickly with less risk of damage and with less loss of weight Nothing but the inherent beauty and excellence of the flax fiber has permitted its survival of competition so formidable The position of the linen trade is a trying one but the experience of the past leads to the hope that the staple trade of Ulster will continue to survive during many future generations To have held the supremacy in the fine linen trade against the world is I trow another flag saved by Ulstermen for the British Empire

SHELLAC AND THE LAC INDUSTRY.*

A MYSTERIOUS AID TO CIVILIZATION.

BY G. CLARKE NUTTALL, B.SC.

SHELLAC or lac is one of those aids to civilization about which there has tended to be an atmosphere of mystery and romance

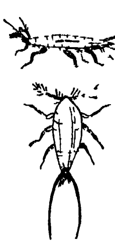
Already familiar to us in the form of sealing wax varnish, furniture polish hat stiffening and the like and of course in the decoration of every conceivable thing hailing from India—trays boxes tables beds shields, and a hundred and one other things—it is nevertheless quickly rising now into vastly greater importance because it has been found essential in electrical work (whose immense development has been of such mushroom growth the past few years) and because too it is largely required in the preparation of gramophone records Hence the exports from India have quadrupled and in 1905 no less than 6 000 tons of it were imported into the United States alone

Now the lac industry is of great antiquity Thousands of years ago, in prehistoric times, the natives knew its value and used it largely There are various references in Sanskrit literature to the lac tree, that is to the palas or dhak In 1590 the great Akbar wrote full particulars as to how lac resin should be used in varnishing the wood of public buildings The first European who described it was a Dutchman who was sent on a scientific mission to India in the sixteenth century by the King of Portugal He published his knowledge of its use and value in 1596—a translation was soon after made in England—but he had no idea whatever of the true origin of the wonderful resin Since that time, it is true we have learnt much about it, but with this sudden leap in value and importance there has now come a great accession to our knowledge

Last year, in an admirable treatise the Forestry Department of the government of India through Mr Stebbing, enabled us perhaps for the first time to obtain a perfectly definite and clear idea of its origin, nature, and manipulation, and of the life history of the insect to which it owes its existence For shellac or lac, as it is generally termed in the initial stages is a product of the animal kingdom and may be defined as a resinous excretion by a scale-insect known as *Tachardia lacca*, a close relative of bugs, plant lice and the like, and a native of India It lives upon many varying native trees though the kusam (*Schleichera trijuga*), the dhak (*Butea frondosa*), the pipal (*Ficus religiosa*), and the arhardal (*Cajanus indicus*) are its favorites It is also found, at times upon the banyan (*Ficus bengalensis*) and upon the mango (*Mangifera indica*)

Great numbers of these insects dwell closely together upon the trees, and each proves to be nothing more or less than an animated miniature syphon At the mouth of every one is a tiny lancet with which it pierces the tree, and through the opening thus made it inserts a sucking apparatus Then it proceeds to draw up into itself the living sap of the tree, this passes through its body, is modified in the process, and passes out again at the other end in the form of lac The lac accumulates and is gradually built up round the insect into a small, red, dome-shaped excrescence. Owing to the myriads of these excrescences they tend to run into one another and form a regular incrustation on the branches.

The life history of the insect may be summarized as follows though it varies in detail in different parts of India About the beginning of July tiny red larvæ can be seen swarming out of the incrustations in countless numbers and spreading over the neighboring twigs Each is oblong in shape with two minute eyes two short antennæ or feelers and six short legs Curious tufts of white powdery hairs the breathing apparatus—grow from each side of the thorax This swarming goes on for two or three weeks not all the insects appearing at the same time but each as it appears immediately sets to work to find a suitable position where it can set up as a syphon on its own account Within twelve hours its fate is sealed and during this time it takes no nourishment of any kind as its whole attention is taken up with settling itself in life A certain number will be successful but a far larger number are doomed owing to their not being able to bore through the cortex at the point they attempt it and hence cannot get at the sap



SIDE AND DORSAL VIEWS OF THE LAC INSECT

A successful insect however settles to work and for about two and a half months goes on steadily forming lac incrustation the female producing a bigger structure than the male At the end of this time the males creep out backward from under the edge of their scales they have grown a little since we saw them first as larvæ and have now larger antennæ and four eyes instead of two (two more having appeared under the head), and they crawl over the twigs looking for the females and fertilising them Then they die, their life work quite finished The females go on forming lac for another two and a half months and developing too, then for a month, the last month of their lives they rest dormant taking no nourishment lying inert The eggs hatch out within them perhaps a thousand in number in each, and the larvæ emerge and swarm trying to find new homes while the mothers shrivel and die

There are thus two generations in every year the second generation beginning to swarm in the early part of December and distinguished by the single fact that the males have wings

Now, the lac insects have various enemies to contend with during their short life Birds are on the outlook for the larvæ when they first swarm and monkeys like the sweet tasting lac and will eat it in considerable quantities and include the insects too in their meal Ants are still greater pests to them for though they do not deliberately eat up the insects themselves yet they feed on the lac with avidity and often injure the insects in so doing Certain caterpillars too will prey upon the lac insect and rain, frost and hail are often injurious to large numbers

Lac is almost invariably collected by natives and the collection is made by breaking off the incrusted branches and twigs These are sold as sticklac to middlemen who take them in large quantities to factories Here they are broken up into short lengths and crushed either by hand or by machinery This crushed matter is divided into three parts (1) the wood which is used up as fuel (2) the dust—khud—sold to makers of bangles and toys (3) the true granular lac which is known as seed lac The next process is to wash the seed lac for twenty four hours the water which runs away from it is a deep purple color and formed the once valued lac dye but is valuable no longer as it has been supplanted by aniline dyes Drying follows the substance being spread out and finally bleached At this stage it is often mixed either with resin to lower its melting point or with orpiment (yellow arsenic) to make it opaque or with both substances at once The mixture is then put into very long narrow cloth bags 10 to 12 feet long and 2 inches wide and held over open fires The worm like bags are slowly twisted and the melting lac oozes and drops on to the floor It is then stretched into thin sheets and sold as shellac All fragments and parings are carefully secured throughout the whole manufacture nothing is wasted and these inferior qualities are sold as button lac and garnet lac

Hitherto the cultivation and collection have been almost entirely in the hands of the natives and hence the methods employed are of the original primitive character But now shellac is becoming so valuable and the demand for it is increasing so fast that the government of India is beginning to interest itself more closely in lac cultivation and the Forest Department has been intrusted with the work of forming lac preserves The matter has become more urgent during the past four years since the price began to rise and prompt action is felt to be advisable In 1896 the value of the export from Bengal was 1 48 55 770 R In 1906 it was 3 14 82 409 R and yet the actual difference in quantity exported was only between 204 072 cwts in 1896 and 271 101 cwts in 1906 The total export from India in 1906 was of the value 4 41 39 706 R

It must be realized that all these facts concerning the life history of the insect are of the greatest importance If the government is to extend successfully the lac industry it must ascertain them before it can know the best time and methods of propagating the insect and the proper trees on which it can thrive Many absolute failures in promoting lac cultivation in the past were entirely due to ignorance of these facts as for instance, mistaking the swarming of the male insects for the swarming of the larvæ During the past two years considerable research and elucidation of the problems of lac cultivation has been done gested that the industry forming forest villages the little grain cul small needs and de such forest work as lac

up of the official report is in teresting It will have become abundantly evident that with the exception of the Central Provinces the department has not realised the immense value of lac as a minor forest product The position has to be faced that the cultivation of the product on scientific lines is not understood But little advance has been made in the production of the substance since the days of Akbar, and the daily increasing demand for the product of which India is the chief producer would seem to necessitate considerably more attention being paid to its collection than has been the case in the past There appears to be small reason to doubt that money expended on this work will yield very large returns

PROFILE PUPPET-SHOW.—III.*

HOW IT CAN BE MADE AND USED.

BY A ROZE.

Concluded from Supplement No 1796, Page 366

Fig 11 is a clown on a comical spotted horse This is composed of eight different parts—four legs for the horse each leg being in one piece then the head next the body of the horse and the clown the arms being movable as in Fig 10 Three life lines *A* only will be necessary for this figure Attached to a simple crutch then moving the crutch forward and backward from left to right some most grotesque movement can be got

Fig 12 shows a trick figure a nice plump little gentleman evidently on his way home with something in the bag for breakfast One crutch *A* only is required for this figure See Fig 1 After the figure has hobbled and danced he suddenly grows taller and taller and becomes himself again Then his neck becomes four times its usual length again he grows tall and at the same time his neck lengthens This will prove a very funny figure See the back view of figure the legs are arranged so that they slide up and down freely through a slip of cardboard glued to the figure which keeps them in position The legs are prevented from falling out by a piece of wood which is glued on at *D* The neck is arranged in the same manner a piece of wood is fixed at *F* To work the figure bring it on as a dwarf the crutch being in the left hand Then by raising both life lines *F* each attached to a boot button *G* thus will raise the figure allowing the legs to drop and lengthen out Next a line *H* is fixed to the hat the upper end above crutch having a button *I* tied on This will raise the neck A few minutes practice and you have the giant or dwarf at will

Last but not least is a Pierrot troupe of entertainers The manipulators for this set should sing one or more ballads and humorous ditties for each figure The back view (Fig 15) shows the mechanism of the figures the threads being only seen and worked at the back and the figures in front as in Fig 14 The seat and bodies of figures and piano are cut in one piece the movable legs arms and heads being separate pieces The movements and working are shown by Fig 15

The whole set piece is kept in position (shown by the dotted lines) by a piece of wood which is shown by the dotted lines *A* one inch in width half an inch in depth and length in proportion so that the end *B* is out of sight of the audience *C* is the same piece of wood but brought forward and enlarged

To illustrate the method of working the figures each has a screw-eye devoted to it through which threads run and again through arches of wire as seen at *F* terminating at *C* and having a boot button or other suitable attachment for manipulation each button when pulled at *C* working its own figure Two or three figures can be worked at one time with practice The joining of this set is the same as for the other marionettes with the exception of the arms of No 1 at *F* also the head *H* and the hands of pianist *H H* which have an eccentric motion explained in Fig 16 which is the head of Fig 14 *A* is the body *B* the head attached to body by wire *C* Next a horseshoe shaped piece of stout cardboard is glued on the back of the head as shown by *D* The head can now be made to rock to and fro kept in its right position by the wooden button *E* which is glued on to the body and of such thickness that it will catch the horseshoe *D* whichever way the head moves To bring the head back to its original position a counter weight may be required This is done by gluing a piece of wood to the back of the head and on opposite side to the thread This mechanism acts also for the arm of Fig 15 at *F* for the tambourine arm No 4 also for the hands of the pianist The joining of the other parts—legs arms etc —is done in the same manner as for the single figures

To work the troupe each figure is controlled by its own threads terminating at *C* where the buttons are pulled The whole of the figures can be worked at the same time by manipulating all the buttons at once but to work in proper order suppose No 2 is singing a ballad about beautiful spring he only lifts occasionally his music up and down the pianist accompanying him The principal threads are hidden from the view of the audience but the ends of some threads are in front view for the Pierrot No 3 with music The thread is passed through a small hole at *X* made by a needle then fixed to the music It will be seen when the thread is pulled that it will raise music and work the arms the latter being firmly attached to the sheet of music All the other figures when the thread passes through to the front are arranged in the same manner

The drawings illustrating this series if carefully studied, will help the amateur entertainer safely through his work Color the figures to fancy using bright colors, and in some give various shapes and designs of bright tinsel paper, thus making a smart and attractive show A little appropriate music to accompany the figures will make the performance complete.

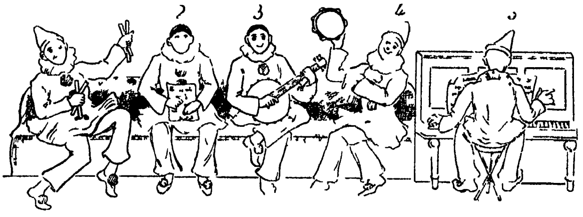


Fig 14

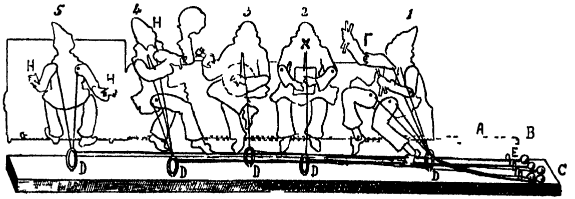


Fig 15

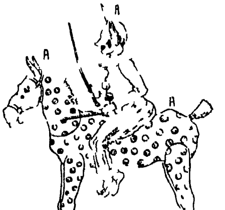


Fig 11

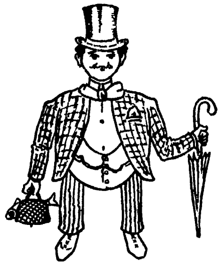


Fig 12

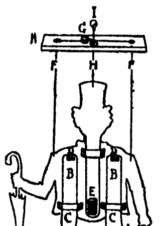


Fig 13

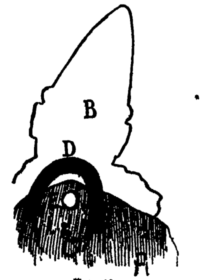


Fig 16

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* English Mechanic and World of Science

THE MANUFACTURE OF GLASS.*

SCIENTIFIC DEVELOPMENTS IN THE GLASS INDUSTRY.

BY DR. R. SCHALLER.

THE manufacture of glass involves first the chemical process of producing glass from the proper raw materials and secondly the mechanical art of fashioning the molten glass into the multitude of articles for which the market calls The mechanical aspect of the industry was early developed to a high state of perfection It is only within comparatively recent times, on the other hand that the chemistry of glass making has been worked out with scientific method The need for such a development first made itself felt with special force in connection with the manufacture of optical instruments and it is largely this circumstance which caused the famous Jena Glass Works to undertake the systematic study of the physical and chemical properties of glass

The influence of the composition of glass on its properties is best brought out by a graphic representation Thus in Fig 1 distances measured off to the right along the axis of the abscissæ represent the composition of a soda glass while the corresponding ordinates represent temperatures The curve drawn out in a full line shows the upper limiting temperature of devitrification This means that a soda glass of a given composition remains glassy provided it is not cooled below that point on the curve which corresponds to the particular composition of the glass Thus for example a glass containing about 75 per cent of silica (SiO_2) and 25 per cent of soda (Na_2O) can be cooled to nearly 700 deg C without devitrifying The significance of this curve is obvious when we consider that in working the glass it must be brought down to a temperature at which it possesses a sufficient degree of tenacity The dotted line on Fig 1 indicates points of equal tenacity It will be seen that at temperatures corresponding to this particular tenacity glasses of certain compositions are below the temperature required to keep them from devitrifying They cannot therefore safely be cooled down to this degree of tenacity Others, in a small region extending about from 71 to 76 per cent SiO_2, are above that temperature and will therefore remain glassy if cooled till they have the tenacity corresponding to the dotted line

The pure soda glasses can not be used for the general purposes to which 'glass is put as they are water-soluble The second diagram shows some of the properties of a lime soda glass such as we have for example in window glass In this diagram the ordinates represent the proportion of soda (Na_2O) and the abscissæ proportion of lime (CaO) It is understood throughout that the proportion of silica (SiO_2) is 100 The lines drawn out in full are lines of equal stability the numerals 2 3, 5 representing increasing degrees of instability The dotted lines correspond to equal temperatures of devitrification The compositions suitable for window glass are those comprised within the field bounded below by one of these dotted lines and above by one of the full lines For if we step outside this region, either the temperature of devitrification is too high so that the glass cannot be cooled down to a working temperature or else the glass is too unstable

In addition to lime and soda many glasses contain also alumina or boron trioxide The effect of these constituents is to increase the stability of the glass In the case of alumina this is probably due to the formation of double silicates of the type of felspar The beneficial influence of the boric oxide is probably due to another cause this body functions as an acid setting free silica

As has already been pointed out the physical and chemical investigations at the Jena Glass Works were in the first place aimed chiefly for the production of new optical glasses. All the glasses known in the earlier days were somewhat similar in their optical properties That is to say, while their refractive index and dispersive power varied within certain limits, they ran parallel throughout, so that if the known glasses were arranged in order of increasing refractive index, this would at the same time place them in the order of their dispersive powers Glasses were needed which should not conform to this order, and it was found that especially barium and zinc possessed in a high degree the property of imparting to glass a high refractive index, accompanied by a comparatively low dispersive power

Another problem was to prepare crown and flint glass which would give as nearly as possible similarly proportioned spectra. The flint glasses then known gave a spectrum which was much more drawn out in the blue than that produced by crown glass The remedy was found in the addition of boric oxide which foreshortens the blue end of the flint glass spectrum

Another class of optical glasses are the colored glasses The principal problem in the preparation of these is to produce as nearly as possible ideal color filters Such a glass must absorb as completely as possible some particular portion of the spectrum while transmitting the remainder The materials added to give the requisite color are the oxides sulphides and selenides of certain metals or in certain cases the metal itself in a highly divided state The color imparted by such additions depends in part on the composition of the glass in which they are dissolved

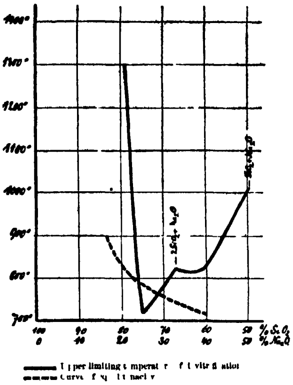

FIG 1

A problem of the same character is the preparation of glasses which transmit very short wave lengths of light It is well known that quartz and boric acid have the property of being transparent to ultra violet rays The presence of metallic oxides more or less completely destroys this property the extent to which this takes place depending on the nature of the metal thus sodium has a stronger effect than potassium while lead glasses are particularly opaque to short wave lengths However by carefully observing certain precautions it is possible to prepare silicate glasses of much greater transparency to ultra violet light than common glass. A special product of this character made by the Jena works and marketed under the name of "uviol glass" has found application especially in astro photography and in the manufacture of the uviol mercury lamp This latter as our readers may remember is used for medical purposes in the treatment of skin diseases and in certain chemical industries especially in the production of linseed oil products

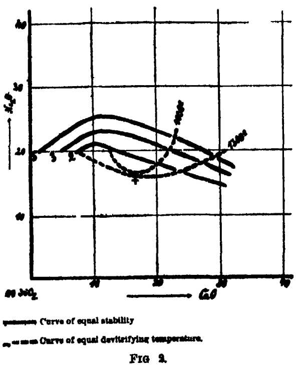

FIG 2.

Another property of glass which is of great importance in connection with certain of its applications is its behavior toward changes of temperature If a hot glass article while still soft is allowed to cool quickly irregularities in density are produced within the mass of glass giving rise to internal strains A glass tube for this reason is always under a peripheral compressing strain while the inside is under tension The consequence of this is a high resistance to mechanical injury on the outside while any scratch on the inside especially in the case of thick walled tubes almost inevitably leads to the cracking of the tube Such tubes in which the outer wall is under a compressing strain and the inner wall under tension nevertheless possess certain advantages over tubes free from strain For if such a tube is heated from within to a temperature considerably exceeding that of its surroundings the thermal expansion of the inner layers must first neutralize the existing tension before the tube can acquire any tangential expansion strain tending to burst the tube Such a tube can therefore withstand considerably higher differences of temperature between its inner and outer surface than a tube initially free from strain The same advantage is gained where the tube is to be subjected to pressure from within as in water gages for boilers For this purpose tubes free from strain cannot be used at all The sensitiveness of the inner wall may be prevented by making the tube of two layers having a different coefficient of expansion with temperature Tubes of this kind are largely employed for boiler gages

A glass having a very low coefficient of expansion will cool without acquiring any appreciable strain Such a glass is particularly well adapted to resist sudden temperature changes and is used for example in making chimneys for incandescent gaslight Another purpose for which glass possessing special properties is required is the construction of thermometers One of the errors to which thermometers are subject is the apparent lowering of the freezing point if the latter is observed soon after the thermometer has been used to measure a high temperature Experiments showed that the simultaneous presence of potash and soda is particularly responsible for a large error of this character Finally the brand known as Jena normal thermometer glass 16 III was evolved and this is now regularly manufactured in uniform quality It is commonly formed with a red streak to render it readily distinguishable Its coefficient of expansion is so nearly alike to that of platinum that the metal can be fused into it making a gas-tight joint Another special thermometer glass is the boron glass 59 III which is particularly well adapted for high temperature thermometers ranging up to 500 deg C This glass is even superior to the first mentioned having a lower coefficient of expansion This however brings with it the disadvantage that a gas tight joint with platinum cannot be made through it by fusion

In conclusion it may be said that the principal characteristic of the advances made at the Jena works during the last twenty five years consist in the production of special glass adapted for definite purposes This was rendered possible only by greatly increasing the variety of types of glass prepared and by the utilization of elements which previously had not been employed in glass making Nevertheless had the demand been exclusively for glasses for scientific purposes this would never have been sufficient to enable the manufacturer to meet the requirements and at the same time secure a margin of profit The commercial possibility of the developments which have taken place necessarily rested on their exploitation for general technical purposes, as for example in the manufacture of the Jena incandescent gas light chimneys

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Patina.—The modern bluish imitation patina on lamps etc can easily be produced by means of a varnish paint prepared by stirring together copper carbonate and a very light colored spirit varnish (sandarac or shellac solution) Verdigris alone used in the same way gives a pale green patina mixed with copper carbonate, it gives the medium tones

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* [illegible] a paper read before the [illegible]

COMMERCIAL MOTOR VESSELS.

THE SUCCESS OF THE MARINE INTERNAL COMBUSTION ENGINE.

If there are still any skeptics who cannot see a future before the internal combustion engine for marine propulsion the list attached to the paper read by Mr Linton Hope at the Naval Architects giving details of 120 commercial craft fitted with this form of power should prove sufficiently convincing Such a collection of data drawn as it is from various sources and embracing vessels of various types is valuable as giving the same sort of indication as a thermometer which by abstracting a portion of the heat from the body tested measures the intensity of it There must be at the present time in various quarters of the globe several thousands of vessels propelled either wholly or as an auxiliary by internal combustion engines and the number is growing daily The question now is not whether motor driven vessels have come to stay but how fast development will proceed in the larger powers which have hitherto been considered outside the practical limits for oil or gas engines Though for many years past the possibilities of the high speed motor have been recognized and made use of in racing craft and other high speed small vessels we shall be probably justified in saying that the stoutly built moderate speed motor suitable for the rough and tumble work in commercial craft hardly existed ten years ago To day its existence is officially recognized by the recently issued regulations of the Board of Trade requiring certain qualifications from the men in charge of such engines similar to those required from those in charge of steam machinery at sea

The industry which has thus emerged from its embryonic state has had its share of infantile troubles At first there was too much tendency slavishly to follow the ideals of the engine as used for road work and the phrase only a motor car engine became a by word to describe unsatisfactory marine installations For this state of affairs marine engineers may be partly to blame for with the conservatism which usually characterizes those that go down to the sea in ships they looked askance at the advent of a form of power which claimed to be able to supersede steam and speaking generally though there are notable exceptions they gave it neither advice nor encouragement Experience however soon showed that the high speeds of revolution were unsuitable for marine work if reliability were made a first consideration For boats which are intended merely as racing machines speeds may be high and weight cut down to the narrowest margin If the engine fails during a race it is just towed back probably by a steamboat the deck hands of which leaning over the side with arms on the rail deliver themselves in true nautical style of caustic comments and opinions on the unfortunate motor boat astern The commercial marine motor must be in an entirely different category Unlike the road engine the highest speed and the heaviest load occur together and the margin of reliability must therefore be very ample For this reason excellent engines for shore purposes may be unsuitable in vessels Whatever merits they possess may be entirely annuled by a single weak spot the failure of which may be unimportant on shore but which by causing a stoppage of the engine at a critical moment would be productive of disastrous consequences at sea Speed of revolution is one of the elements of reliability and speeds are being reduced not only from this reason but also because of the difficulty often found in getting an efficient propeller for the higher speeds This has been noticed in the case of several of the East Coast herring drifters which have been fitted with oil engines The speed in some cases is up to expectation in smooth water but in a number of cases it is found that the motor has little effect in driving the boat against a head sea Nor is this surprising when we consider that the drifter propelled by the oil engine has a much higher speed propeller with a disk area of only about a fourth that of the steam drifter

We know now from recent turbine experience that high speed propellers need not be inefficient and that an important factor is the position of the propeller relative to the hull In many of the fishing boats the propeller is so small as to be largely masked by the dead wood and it cannot therefore get so good a supply of water as it should for maximum efficiency Twin screws if admissible on other considerations would go far to meet the case but failing this expedient the speed of revolution should be largely reduced from that which now generally obtains though there is no necessity to reduce to the same low level as that at which the steam drifter runs The reduction of revolutions means of course a larger and more expensive engine but the benefits already derived from the use of power in these fishing boats indicate that the increased speed and efficiency to be obtained by slower running engines will amply repay any extra cost entailed

It is desirable that the idea should be abandoned that because an engine is labeled a motor it therefore must run at a high speed The speed of the motor must be subservient to the purpose for which it is required This has been recognized on the Continent where the oil and gas engines which have been fitted in large numbers for canal and river work are invariably of the slow or moderate speed type With moderate speed engine there is still a large margin of saving in weight to be made over steam machinery of moderate power though it is now generally accepted that the margin will be less as the power increases There is thus everything to gain weight and economy of running and upkeep by extending the use of motors in vessels requiring powers up to two or three hundred horse-power Beyond that we are as yet in the dark as to possible developments, but there is still a very large field in fishing boats small trading and coasting vessels requiring power up to this limit Unfortunately for rapid progress this class of business is generally in the hands of men of relatively small means who cannot afford to experiment and the brunt of the pioneering expenditure will have to fall on the makers of the engines It is also fairly evident that it will be wise to wait the results of experience in the moderate sizes before proceeding to the powers required by the ocean tramp It is generally conceded that when we pass the limit of about 200 horse power the ordinary reversing arrangement by friction clutch and gearing which may be made quite satisfactory up to those powers will have to be superseded either by making the engine reversible or interposing a reversible transmission such as an electric dynamo and motor The possibilities of gearing down must also not be overlooked as this allows the speed of the engine to be kept up and the turning moment of the engine shaft may remain such that friction clutches and gearing may still be employed All these schemes will no doubt in time be tried and equally without doubt the fittest will survive When the line of development of the larger sized engines has been determined there will be found an enormous field for their application There are the steam trawlers for example which are of higher speed and engine power than the drifters and present also some pretty problems for the application of the internal combustion engine to the auxiliary appliances with which they are fitted such as the refrigerating machinery steering engine and windlass. It is notorious that these vessels earn a dividend with difficulty and the difference between a small dividend and none at all may be made by a shilling a ton on or off the price of coal These trawlers now go so far afield that the reduced consumption of fuel will be of considerable advantage in giving them an increased radius of action besides the direct advantage of economy We are still yet a little way off from the commercial marine motor of 1000 horsepower and above but in the meantime we have learned much from what has been done already and the way is steadily being prepared for further developments — The Engineer

THE LIBERATION OF ELECTRONS DURING CHEMICAL REACTIONS

Those who retain their doubts as to the real existence of electrons may be interested in the account of some experiments by F Haber G Just and F W Robinson of Karlsruhe described in the *Zeitschrift für Electrochemie* Metals are supposed to be rich in electrons (negative particles) which are credited with playing an important part in the conduction of electricity through the metals while metallic oxides are said to be devoid of electrons The electrons might therefore be lost during chemical reactions between metals and other elements and if the other element were a gas that gas should assume a negative charge and the current of gas should so to say blow the escaping electrons away from the surface of the metal It occurred to Haber to study this phenomenon with the easily oxidized alkali metals which were applied in the experimentally more convenient form of amalgams Potassium sodium amalgam was made to drip from a glass funnel the concentration of the amalgam (which will be more or less liquid according to its percentage of mercury) being such that about four drops fell per minute The drops fell within a cylinder of platinum gauze which was charged from a battery as a rule to 2.5 volts A current of gas was passed through the cylinder and the whole apparatus enclosed in a black box to shut out all light which would itself have an ionizing effect In spite of all precautions the platinum gauze slowly lost its charge owing to the difficulties of maintaining perfect insulation a loss of 1.5 volts took about 4 minutes with a positive charge of the gauze and 6 minutes with a negative charge in a chemically indifferent atmosphere of pure nitrogen or hydrogen When the atmosphere contained gases which would react with the alkali metal viz, oxygen iodine etc — the loss was much more rapid, taking a few seconds. The loss of the charge was therefore not merely an effect of frictional electricity there was friction between the gas current and the metallic surface It was moreover observed—and this is the chief point that only the positively charged gauze cylinder was discharged not the negatively charged so that the particles concerned must be electrically negative particles The experiments were made first with indifferent gases and then with gases containing also water vapor oxygen and other constituents such as would react with the alkali metal The complete drying of a gas is of course an exceedingly difficult operation and in view of the researches of Brereton Baker it would be most interesting to ascertain whether any liberation of ions and reaction would result in a perfectly dry atmosphere that was impossible however with the somewhat complicated apparatus But the observations of Haber were checked in various ways When the nitrogen or hydrogen was pure the surface of the amalgam remained bright, in the presence of water vapor or oxygen it became dull, owing to the formation of an oxide film and in that case the rapid discharge was always noticed Interference colors—yellow red green depending upon the thickness of the film—were also observed and light likewise produced a discharge Among the active gases tested were hydrochloric acid iodine vapor (which was inactive at 79 deg C (—61 7 F) when any vapor originally admitted into the tube system would be condensed again before reaching the amalgam) thionylchloride (also inactive at low temperature) and phosgen Thus the conclusion appears to be justified that a current of chemically active gas liberates electrons which produce a loss of a positive but not of a negative charge This conclusion is not in accord with similar experiments of G Reboul first brought before the Paris Academy of Sciences in 1908, the experiments of Haber began later Reboul observed a loss of both positive and negative electric charges during certain chemical reactions But it would appear that he did not take particular pains to start with pure metallic surfaces and that he would thus overlook the unipolar character of the phenomena occurring during the first stages of his experiments —Engineering

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In the **Comptes Rendus** Robin describes the phenomena of the extinction of sound in iron A rod of iron suspended from a point near a vibration node gives a musical sound when struck accompanied by a feeble deep hollow note in bars of sufficient length The first mentioned sound is produced most distinctly when the rod is suspended at a point about one-quarter or one third of its length from one end A comparison of the notes given by five very pure steel bars of similar dimensions and differing only in the proportion of carbon present showed that the pitch varied inversely as the proportion of carbon The differences are feeble but their detection is aided by the usual manifestation of beats when two rods are set in vibration near one another When the temperature is increased, starting from the ordinary temperature, the pitch of the note diminishes in a regular manner and the intensity of the sound becomes rapidly less, disappearing altogether just below 100 deg C in the case of iron and steel low in carbon When the temperature is further raised the sound reappears at about 150 deg C grows to a maximum and vanishes again at a dull red heat. This anomalous variation of the intensity of the sound with the temperature appears to be characteristic of iron and possibly of nickel The range of aphony varies according to the amount of carbon With 0 2 per cent of carbon it is complete between [illegible] deg and 147 deg C.; with 0 45 per cent of carbon it is complete between [illegible] deg. and 120 deg. C In the case of a steel containing 1.3 per cent of carbon and containing cementite, the intensity of the sound remained approximately constant from the ordinary temperature up to red heat.

THE MALLET LOCOMOTIVE IN SERVICE.*

THE PERFORMANCE OF A WONDERFUL ENGINE.

When it is claimed, or even suggested, that a Mallet articulated compound locomotive can be maintained as cheaply as an ordinary simple engine of half its capacity, the statement must be attributed to enthusiasm or ignorance The Mallet is, to all intents and purposes as far as repairs are concerned, two complete and independent locomotives with the exception of the boiler That it should be possible to maintain these two engines as cheaply as one does not stand to reason and is not borne out in practice Records show that a Mallet costs something more than twice as much per mile run for repairs as a consolidation of about two-fifths its tractive effort The saving in repairs on two boilers is offset by the expense for the extra parts such as jointed receiver and low pressure exhaust pipes To put the matter definitely it costs about 23 cents per mile for repairs on heavy Mallets as compared with from 7 to 10 cents for consolidations of less than half the tractive power and they are out of commission from 20 to 2[illegible] per cent of the time

Still they are economical where a heavy power is required and they can be made to take the place of two lighter engines They cut the wages in two and the compound feature effects a saving in coal of from 15 to 20 per cent per horse power produced the repairs drop to about 2 cents per 1 000 ton miles instead of 3 5 cents with heavy consolidations From an operating standpoint, also it is very evident that one engine is better than two especially if it can be handled as readily as one of the smaller units and this is the case The largest of the Mallets can be spotted as easily as any smaller engine and may be handled with any desired degree of delicacy

Whether it will be possible to extend their radius of action from short pusher runs to regular road service is quite another question It is all very well to assert [illegible] and that the fireman has [illegible] is quite true [illegible] ri[illegible] h[illegible] to the [illegible] p[illegible] grade, a[illegible] without [illegible] ing without [illegible] tion of th[illegible] the work [illegible] of these [illegible] grade w[illegible] the pace [illegible] dred and [illegible] ity one [illegible] lons of [illegible] four tons o[illegible] With[illegible] foot plate i[illegible] to add to the [illegible] interrupted only by raking and leveling and without an interval for the taking of breath The rate of combustion must be kept at the highest pitch and the heat from the opened door is scorching in its effect It is here that the mechanical stoker becomes a necessity if the run is to be extended to cover a division There is but one mitigating circumstance in its use for road service and that is under ordinary conditions the engine would not be crowded so hard continuously In pusher service the reverse lever is dropped down in the corner and left there whereas on a road run it would be hooked back causing [illegible] on the consumption of steam per revolution but probably requiring quite as rapid a rate of evaporation per hour

Of course where oil is used as a fuel the whole situation is changed and the physical strain on the fireman is avoided and the suggested limitation of the radius of action does not exist as far as the man is concerned but it remains to be seen whether a locomotive boiler can be built within available dimensions that can meet the evaporative demands of a big Mallet when pulling a heavy train at road speeds

As for the action of the engines upon the track it appears that they have lived up to the claims made for them by their designers While it is not known as to just how they distribute their lateral stresses upon the track any more than it is of other locomotive types still where one Mallet has been substituted for two or more consolidations on a pusher grade the wear of the rails has been lessened from which it has been inferred whether rightly or not cannot be stated that these new locomotives are easier on the track

Mallet locomotives are capable of making from [illegible]0 000 to 40 000 miles between general repairs and in some instances the latter figure has been exceeded An examination of the 0 1 4 0 locomotives that have been out of the shop for four months shows that the tires are in remarkably good condition There is no perceptible flange wear on any of the wheels except the leading pair of the front engine which show a decided tendency to run sharp This is probably due to the fact that the engine is working hard when run forward as half of the mileage [illegible] when running backward light

The internal resistances of the engine are somewhat higher than those of the ordinary types A Mallet locomotive will not drift down a 1 per cent grade An Atlantic would attain a high speed in such a place and a consolidation would run faster than would be allowable whereas steam must be used with the Mallet in order to get down at all As to what percentage of the total power developed this amounts to accurate data are not available but when added to that required to raise the weight of the engine and tender up the grade it must be a goodly proportion of the drawbar pull available at the back of the tender

Again the wear of the connections between the front and rear units seems to indicate that there is not always that harmony of action between the two that is to be desired It may be the effect of imagination but there seems to be a surging action when the engine is at work closely resembling that felt on ordinary engines when they are not properly counterbalanced This is especially noticeable on the firing platform but is scarcely perceptible in the engineer's cab except when running light Unless the connections are made far stronger than any calculations would indicate to be necessary there is apt to be a breakage and a separation of the castings When the engine is pushing the action is not so apparent for then the front unit is pushed back by the load and the after one tends to run up on it so that the two are brought together but when pulling the forward unit can surge away from the rear one with the full force of the maximum power that it can exert This movement is especially noticeable when the engine is running light It ought to be met by putting an excessive strength into the connecting parts

Very little leakage occurs at the ball and expansion joints of the receiver and exhaust pipes and no serious trouble has been experienced Evidently the designers looked upon it as a place requiring especial attention and by giving it have obtained very satisfactory results

The cab must necessarily be one sided As the fireman is away in the rear and communication from one side to the other is out of the question everything must be on the right hand side this includes the throttle and reverse levers two injectors two cylinder lubricators two sets of cylinder cock levers two sanders engineer's brake valve and straight air brake valve water glass and cocks whistle and bell cords steam valves for oilers and emergency valve for converting to simple action With the wide fire box and the limited space available there is not much left for the man when all of these appliances are in place Still the arrangement is quite convenient and because of its air reversing gear the engine is easily handled

Under ordinary conditions of service the emergency exhaust of the intercepting valve is rarely opened even when starting a heavy train There is usually enough slack to be obtained for the high pressure cylinders to exhaust once or twice before the full load comes upon the engine and then the low pressure unit is at work

Hence whether the Mallet is regarded from the standpoint of the mechanical operating or track departments or of the engineer in the cab the locomotive must be considered a very satisfactory machine The only man who has serious objections to it is the fireman who is called upon for such strenuous exertion for him the mechanical stoker ought to solve the problem and thus relieve him of what seems to be an impossible task

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* From Railway Age Gazette

CHAINS FOR POWER TRANSMISSION

In an interesting paper read by Mr A S Hill before the Incorporated Institution of Automobile Engineers, on the use of chains for power transmission, the author according to Engineering gives the history of the different kinds of chains now used for driving purposes, with a description of the methods adopted in their manufacture As is well known great advances have been made during the last few years in the design and workmanship of these appliances Ewart's type of detachable malleable iron chain for conveyors and similar purposes has for long been known and has had a very wide application, but it is probable that the production of a really satisfactory chain for driving purposes has been due to the demands of the cycle trade perhaps the greatest advance in this line being made by Mr Hans Renold, who introduced his roller-chain in 1880 This was, of course, but the commencement, but from it the present excellent chains of this class may be traced A standard ½-inch pitch roller chain of to-day weighs only from 3 ounces to 4 ounces per foot, has a breaking strength of 2,000 pounds, and will run up to a speed of 800 feet per minute at least, with satisfactory results. The accuracy of these chains is remarkable, as may be realised when we consider that one of them, 56 inches long, contains 560 different parts and 112 joints; a limit of 1-32 inch is guaranteed in the length, or an average limit of 0.0003 inch per joint. The roller chain has now largely superseded the block-chain, which used to be applied to all bicycles and which gave satisfactory results for speeds up to 600 feet per minute. In the early days of motor-cars the [illegible] was [illegible] used as a means of transmitting the drive to the wheel It was however afterward replaced by the roller chain Single roller chains have a remarkable wearing power as is proved by the fact that they have lasted remarkably well on automobiles working under very unfavorable conditions Mr Hill considers that although they have largely been replaced by the use of the live axle which forms a clean well housed piece of mechanism there is still something to be said in their favor They have a higher efficiency for transmitting power than high reduction bevel or worm gears and also possess more flexibility They are also fairly accessible even when inclosed in cases Another advantage claimed for them is that they do not place so much weight on the parts not supported by springs as do live axles The inverted tooth type of chain has in many cases taken the place of the roller-chain particularly where large powers have to be transmitted It was originally designed to transmit higher powers than the roller-chain and has become very popular and is now much used in connection with motor drives and high speed engines Its great advantage is that its links take a bearing on the face of every tooth with which the chain engages, and as the pitch of the chain increases, due to wear, the chain ascends the angular faces of the teeth and assumes automatically an increased pitch circle and accommodates itself to the wheel All the teeth also in the arc of contact transmit the same power independently of any increase in the pitch due to wear The author states that there is now a chain of this type being manufactured which is 18 inches wide, with a pitch of 2½ inches, and will transmit 350 horse-power The chief advantages of a chain-drive are That the drive is positive it has a high efficiency tension is not necessary to make the chain grip the wheel as is the case with belts there is a minimum of journal friction and in the case of inverted teeth compared with other forms of tooth gearing the drive is very noiseless These no doubt are advantages well worth consideration

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Discussing the question of the weight of motor cars the Autocar states that there is no such thing as absolute rigidity and the most scientifically built car is that which provides just that natural amount of spring and give in the structure as a whole which is desirable and at the same time does not contain a single part which is insufficiently strong for its work Anything more than this means the carrying of needless weight which in its turn not only results in unduly rapid wear of tires but also means slow climbing lack of liveliness and waste of petrol On the level and downhill so far as speed is concerned weight is no advantage Speaking broadly it may be said that the heaviest cars in proportion to their power are the smaller ones as many of these are almost as heavy as cars of considerably higher power At first glance it would appear that either the smaller cars are needlessly heavy or that the larger cars are insufficiently strong However practice has shown that neither the one assumption nor the other is correct and that both cars are just about the right strength and therefore presumably of about the right weight for their work Considering the experience gained and the improved materials now available it cannot be said that as a whole weight has been kept down quite as much as it should have been.

HEREDITY.

Concluded from Front Page

Heredity has for the stockman and plant breeder a well recognized commercial value because by a knowledge of its laws he is enabled to produce in greater number or with greater certainty animals or plants of a particular type Indeed much of our present knowledge of heredity has been derived from a study of the domesticated animals or of the cultivated plants and from the same sources we may expect to continue to draw for here alone have we an unobstructed field for observation and experiment the indispensable tools of scientific research Just as the sciences of anatomy embryology physiology and pathology progressed but slowly so long as the phenomena of the human body alone were considered but advanced by leaps and bounds when comparative studies on other animals were undertaken so concerning heredity in man we have learned and can expect to learn but little from the study of man alone but much from a study of other animals and of plants and from a comparison of the phenomena in the two cases

the body as a result of use disuse or other agencies are not inherited because they have not affected the constitution of the germ plasm carried within the body

Weismann's two principles are of fundamental importance to a right understanding of heredity They are (1) That the germ plasm is independent of the body containing it or as Weismann put it, that the germ plasm is continuous from generation to generation whereas the body dies and (2) that acquired characters are not inherited

The hottest biological discussions of the last twenty years have been waged over these two principles and the contest is by no means ended but year by year the correctness of Weismann's contentions is more generally admitted

Common experiences support both principles Thus the independence or continuity of the germ plasm has been shown from time pre-historic in the practice of castration upon the domesticated animals or upon man The germ plasm is localized in particular organs

vidual whether an animal or a plant has its beginning in the union of two bits of germ plasm, an egg cell furnished by the mother and a sperm cell furnished by the father Whether the union of the germ plasm takes place within the maternal body or not is quite immaterial, among a great many animals it does not

The new individual it will be observed, is dual in origin and to its dying day it retains a dual nature For the maternal and paternal contributions of germ plasm retain a certain distinctness as we shall see, and may in part separate from each other at reproduction

Each germ cell (egg or sperm) so far as its contribution to heredity is concerned stands for a complete organism of its species bears the potentialities of a complete organism and under appropriate conditions can develop into such an organism For this idea we have strong experimental evidence It has long been known that the eggs of certain species of animals can develop without fertilization i e, without

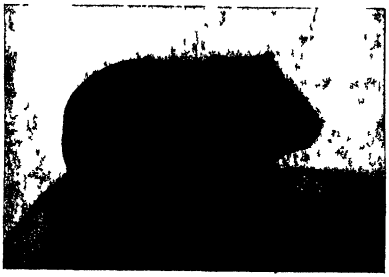

FIG 9 —A DARK SMOOTH GUINEA PIG

FIG 10 —A

FIG 11 —A DARK ROUGH GUINEA PIG

[illegible] are mated like those shown in Figs 9 and 10 respectively

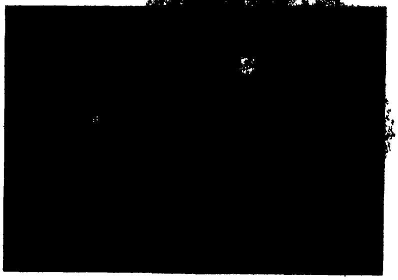

FIG 12 —A WHITE SMOOTH GUINEA PIG

A [illegible] new combination of characters but obtained first among the grandchildren of such animals as are shown in Figs 9 and 10 Other grandchildren are like the respective grandparents (Figs 9 and 10) or the parents (Fig 11)

HEREDITY

Every new individual arises out of material derived exclusively from its parents This is the basis of heredity But it does not follow that the new individual will resemble its parents merely It may resemble remote ancestors more strongly than either parent For it represents a combination of materials or of qualities derived from the two parents and it is possible that neither parent may manifest all the peculiarities which it transmits to the offspring For the parent is made up of two distinct parts its own body and the reproductive substance contained within that body and the two may not be identical in character

The reproductive substance has been called by Weismann the germ plasm He it was who first clearly recognized the fact that the germ plasm is distinct from the body which contains it and that the influences which modify the character of the one do not of necessity modify the character of the other Thus he was able to show experimentally that mutilations of the body as loss of the tail in mice are not inherited and to establish with a considerable degree of certainty the principle that characters acquired by

of the body the reproductive glands If these are removed reproduction becomes impossible though all other functions of the individual persist. Further it is possible to show experimentally that the germ plasm transplanted from one individual into another retains the character which it originally had, quite unaffected by the changed body with which it is associated This Dr John C Phillips and the writer have recently shown in the following way The ovaries were removed from a young black guinea-pig Fig 1, and these were transplanted into the body of a white guinea pig previously castrated Fig 2 The white guinea pig was now mated with another white guinea pig Fig 3 Normal white guinea pigs produce only white offspring when mated with each other but these two have now produced in three successive litters six young all black Three of these are shown in Fig 4 Evidently the germ plasm of the black guinea pig retained its original character even after transplantation into the body of a white one

In order better to understand the processes of heredity we should be familiar with what takes place when a new individual is formed The new indi-

having united with a sperm or male sex-cell In such cases there can be no question that the potentialities of an entire organism are contained in the egg, for without any outside help the egg develops into a complete individual of the species In recent years it has been shown that the eggs of many species in which fertilization normally occurs may by artificial means be made to develop without having united with a sperm This is true of the eggs of sea-urchins, starfishes and of certain worms and mollusks Such eggs artificially stimulated to development produce entire individuals, similar to those produced by fertilization, but possibly less vigorous.

On the other hand, a sperm cell may be made to develop if it is allowed to penetrate into a fragment of an egg, even a fragment which lacks the important cell nucleus In such cases the entire nuclear material of the embryo is furnished by the sperm, yet the embryo so produced is complete lacking no essential part, and similar except in size and vigor to normal embryos produced by fertilization

Accordingly the evidence is fairly complete that each germ-cell (egg or sperm), considered as [illegible]

[illegible] heredity represents a complete organism and [illegible] an individual produced by the union of two such germ-cells represents twice over each heritable trait of the species. In other words the germ cell is single, the individual is double

This fundamental principle of the singleness of the germ in contrast to the doubleness (duality) of the individual receives the fullest confirmation from experimental breeding.

If we mate a pure-bred black guinea-pig with a white one, the young are all black pigmented This result seems to violate the principle previously stated that both parents contribute equally in heredity In reality, however that principle is not violated The white parent has contributed its own character to the offspring, but that contribution is unseen in them simply because black hides it The white will reappear among the grandchildren In Fig 5 we see a mother guinea-pig having a jet black coat Beside her are four young of the same color as herself The father too was black In a word this black race breeds true A female of this race was mated with the albino male shown in Fig 6 Albinos have white hair and pink (unpigmented) eyes the red eye color being due to the blood which shows through they breed true among themselves but the result is very different when they are mated with black individuals Two children of the albino male and the black female are shown in Fig 7 They are intensely black pigmented as are all the young produced by this cross Two of them when grown to maturity and mated with each other produced a litter of four young shown in Fig 8 Three are black pigmented like the parents but one is an albino similar in all respects to the albino grandsire Here we notice the reappearance of the albino character after skipping a generation The albino grandsire really made a hereditary contribution as regards the character hair color but it did not show in the children because black also was present in the children and black obscured or dominated the white

Applying our principle of single germ dual individual to this case we see that the facts observed are fully in harmony with it The original cross brought together the character B (black) and W (white) into an individual (or zygote as we call it a joining together) B W which showed only black Two such individuals a male and a female were now mated together In the for[illegible] of germ-[illegible] by these individuals there is a [illegible] to the single condition B separates from W [illegible] into a different germ-cell Accordin[illegible] eggs B and W respectively [illegible] of a like character Now a [illegible] from a union of an egg with [illegible] other sort of sperm may uni[illegible] egg which it chances to mee[illegible] the next generation three [illegible] individuals) viz BB BW and W[illegible] as in the previous generati[illegible] the occurrence of these three [illegible] BB 2 BW and 1 WW Any indi[illegible] character B will be black so [illegible] well as the BBs will be black a[illegible] three blacks to one white These [illegible] proportions The white individu[illegible] no other character because it contains only W Such is indeed the observed fact Any two white individuals mated together will produce only white offspring But, if our reasoning is correct two thirds of the black individuals of this generation (viz. the BWs) should transmit white as well as black while the remaining one third BB should transmit only black Experiment justifies both these conclusions If we mate the black animals of this generation one by one with albinos we find that on the average two out of three of them will produce white offspring as well as black ones while the third one produces only black offspring

The scientific law which governs the inheritance of albinism and of other characters transmitted in a similar fashion is known as Mendel's law It applies apparently to all cases of color inheritance as well as to the inheritance of characters of many other sorts. Through its operation new combinations of the peculiar characters of individuals or of races can be obtained in the course of one or two generations Thus when a guinea-pig showing the two coat-characters seen in Fig 9 dark and smooth coat is mated with one showing the combination white and rough Fig. 10, young are produced showing a wholly new combination dark and rough Fig. 11 And if these young are at maturity bred together a fourth combination white and smooth appears among their young the grandchildren See Fig. 12 Other grandchildren manifest the combinations seen, respectively in the parents and in the grandparents. By selection any one of these combinations may be obtained in a pure race.

Oftentimes a new combination of characters obtained through crosses coincides with a lost racial combination. Then the phenomenon is called reversion or atavism. Thus when yellow rabbits are crossed with black ones, gray offspring are obtained similar to [illegible] [illegible] There is no longer anything mysterious about the process it is simple recombination of different unit-characters formerly associated together in the same race but since isolated in some of the derived races

Very different in nature apparently from the Mendelian inheritance of unit-characters is the result obtained when races of animals are crossed differing in size or in the proportions of their parts In such cases the children are intermediate in character and the grandparental conditions do not reappear among the grandchildren The result may be described as a blend apparently permanent Fig 13 shows the skulls of three rabbits all adult father mother and son The skull of the son is shown between that of his parents the mother's skull being at the right. Size and proportions of parts are clearly intermediate in the son No grandchildren were obtained like either grandparent in size The color of the coat in this same family of rabbits clearly follows Mendel's law although the size characters blended The practical result is that one may at will produce a race of rabbits of any desired size within the known limits of variation in size among rabbits and with any of the conceivable combinations of color factors Size variation is apparently continuous and its inheritance blending color variation is discontinuous and its inheritance Mendelian

Notwithstanding the seemingly radical difference between these two types of inheritance it is possible that they may after all prove to have a common basis Blending inheritance may possibly be only a complex sort of Mendelian inheritance in which many independent factors are simultaneously concerned The question is one of much theoretical interest Its solution awaits further investigation

What has already been accomplished in the study of heredity gives us a hopeful outlook for the future We are gaining a fuller knowledge of its processes and a knowledge of processes is a first step toward their control

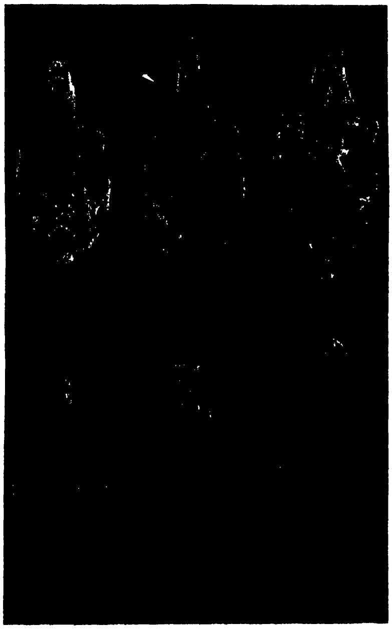

FIG 13 SKULLS OF THREE RABBITS

Mother [illegible] father [illegible] son [illegible] publication No [illegible] Carnegie Institution of Washington by permission

HEREDITY

W. M. Lyon in the Hawaiian Planters Monthly writes on Pickering's Bordeaux mixture According to Pickering, the chief aim in making Bordeaux mixture should be to reduce the lime to the lowest possible proportions consistent with the precipitation of all the copper Comparative experiments have been made with a view to determining the effect of treating sugar cane cuttings with Pickering's mixture. Twelve parallel rows of Lahaina cane cuttings (each cutting having two eyes) were planted out. Six of the rows were planted with cuttings inoculated with the pineapple disease of these six rows three had had the cuttings soaked in Pickering's mixture for one hour one in water and one in normal Bordeaux mixture also for one hour while the remaining row had untreated cuttings The other six rows only differed in that their cuttings were not inoculated It was found that Pickering's mixture injured the cuttings seriously more than half of the eyes failing to germinate The inoculated cuttings were much poorer than the noninoculated ones thus showing that the pineapple disease was able to enter the [illegible] despite the presence of an excess of copper sulphate The investigation proved conclusively that Pickering's formula should not be used in preparing Bordeaux mixture for the treatment of cane cuttings it also showed that copper sulphate can materially injure or even kill the eyes of [illegible] cuttings so that in preparing Bordeaux mixture for the treatment of cuttings care should be taken that no considerable excess of copper sulphate is present in the mixture [illegible] can be avoided by the use of a proper amount of lime The cuttings treated with normal Bordeaux mixture were found to give the best and most rapid germination

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The Swiss Commission appointed to investigate the question of earth as the return circuit in direct-current systems has recently issued its preliminary report. After some introductory tests the permission of the Lausanne Corporation to run with the earth as the return circuit on the Saint Maurice Lausanne line was readily obtained but the railway telegraph authorities noticed disturbances in certain of their lines and so refused permission at first The difficulty was however got over in 1908 by the simple device of inserting a few opposing cells in the telegraph lines affected and so neutralising the action of the drop in the (constant current) earth return The arrangement proved so effective that the desired permission was then obtained and after the necessary batteries had been put into use at four of the stations along the line the earth return service was adopted and has been in regular use from August 1908 up to the present time without any interruption The return circuit can be changed over from earth to line (a second wire being available) at any time if desired in three or four minutes

THE CHEMISTRY OF BODY SECRETIONS.*

REGULATION OF THE PROCESSES OF THE BODY.

BY PROF. WILLIAM H. HOWELL, JOHNS HOPKINS UNIVERSITY.

At the time of Sir Charles Bell physiologists were beginning to realize the great importance of the nervous system as a mechanism for regulating and coordinating the varied activities of the body. To use his own expression, The knowledge of what is termed the economy of an animal body is to be acquired only by an intimate acquaintance with the distribution and uses of the nerves. Since his time experimental investigations in physiology and clinical studies upon man have combined to accumulate a large fund of information in regard to the regulations and correlations effected through nervous reflexes. No one can doubt that very much remains to be accomplished along these same lines, but in recent years we have come to understand that the complex of activities in the animal body is united into a functional harmony not only through a reflex control exerted by the nervous system, but also by means of a chemical regulation effected through the blood or other liquids of the organism. The first serious realization of the importance of this second method of regulation came with the development of our knowledge of the internal secretions during the last decade of the nineteenth century. The somewhat meager information possessed at that time in regard to these secretions developed in the fertile imagination of Brown-Séquard to a great generalization, according to which every tissue of the body in the course of its normal metabolism furnishes material to the blood that is of importance in regulating the activities of other tissues. This idea found a general support in the facts brought to light in relation to the physiological activities of the so-called ductless glands, and subsequently in the series of remarkable discoveries which we owe to the new science of immunology. In recent years it has been restated in attractive form by Schiefferdecker in his theory of the symbiotic relationship of the tissues of the body. According to this author we may conceive that among the tissues of a single organism the principle of a struggle for existence, which is so important as regards the relations of one organism to another, is replaced for the most part by a kind of symbiosis, such that the products of metabolism in one tissue serve as a stimulus to the activities of other tissues. If a muscle is stimulated to greater growth by an excess of functional activity, the substances given off to the blood during its metabolism act favorably upon the growth of other muscles which are not directly concerned in the increased work, or upon the connective tissue surrounding and permeating the muscular mass, and conversely the development of connective tissue from any cause aids directly by its secretions or excretions in the growth of the muscle. There is thus established a *circulus benignus* by means of which each tissue profits from the functional activity of its fellow tissues. From many sides and in many ways facts have been accumulating which tend to impress the general truth that the coactivity of the organs and tissues may be controlled through chemical changes in the liquid media of the body, as well as through nerve impulses, but in physiology at least we owe the definite formulation of this point of view to Bayliss and Starling. Through their investigations upon secretin they obtained an explicit example of how one organ controls the activity of another organ by means of a specific chemical substance given off to the blood. Other facts known in physiology in regard to the internal secretions were easily brought into line with this definite instance furnished by the secretin, and Starling's convenient term of hormone as a general designation for such substances has served to give a wide currency to the conception. The word and the generalization implied by it have been adopted by investigators in many fields of biological research to explain phenomena of correlation which heretofore it has been impossible to bring under the general rubric of nervous reflexes, phenomena which in fact it has been difficult to express clearly in any precise way such as might serve to stimulate direct experimental investigation. An interesting example of this application of the term and the idea contained in it is found in the theory advanced by Cunningham to explain the development and inheritance of secondary sexual characteristics. This author constructs a system of hypothetical hormones which if present would account not only for the development of the secondary sexual characters as the result of the action of specific hormones furnished by the reproductive cells, but would also make conceivable a method by which these secondary characters like other somatogenic characters might affect the germ cells in turn in such a definite way as to be transmitted to the following generations. It is not my purpose to criticise this or similar theories. They will doubtless serve a good purpose in stimulating and directing investigations. It does, however, seem probable that the term hormone, like some of the useful terminology of immunology, will be overworked, and that investigators may deceive themselves as well as others when they conclude that any given relationship is an example of hormone regulation. It has occurred to me that it may be useful in connection with this symposium upon the internal secretions to review very briefly the state of our knowledge in regard to the hormones, with the purpose of discussing somewhat the probable nature of their action and the extent of their distribution.

In treating this subject one must consider also the more or less nearly related instances of combined activity of a chemical sort which are expressed by such terms as chemical activators, kinases and coferments. These terms, like that of hormone, are relatively new; they have been brought into existence by investigators to explain or to express special reactions connected with metabolism and particularly with the action of ferments. Their precise meaning must be determined by further knowledge of the facts they are intended to describe, but something may be gained by attempting to define them as they are used in physiology at present. The word activator has reference to the fact long known that the ferments, or some of them at least, are secreted in an inactive form, a proferment, which is activated or converted to an active form by a reaction with some definite substance produced elsewhere in the body. Pepsin, for example, *is secreted as pepsinogen and is activated to pepsin* by the hydrochloric acid formed by other gland cells. Calcium salts are necessary for the activation of the prothrombin and enterokinase, or calcium plays a similar role with reference to the trypsinogen. It is to be noted that reactions of this kind are not confined to the ferments. The typical hormone secretin exists in the form of an insoluble prosecretin which may be activated by acids, and according to Delezenne calcium takes an essential part in the activation of enterokinase in somewhat the same way as occurs with thrombin. The nature of these activating reactions is not known. The view has been proposed that the inorganic constituents involved, the hydrochloric acid and the calcium, for example, act as catalyzers which accelerate a reaction that would occur without their assistance. There is, however, no evidence to show that thrombin is formed in any amount in the absence of calcium salts, nor that pepsinogen yields pepsin without the presence of acids. As Bayliss has pointed out, these reactions belong to the irreversible group, and it is possible that the activator or one of its constituents is represented in the composition of the active substance that is formed. However that may be, it is to be noted that the process of activation is an instance of chemical co-ordination. The pepsin formed in one kind of gland cell is activated by the acid produced in a different variety of cell. The hydrochloric acid produced in the stomach is carried into the intestine with the flow of chyme, and there activates the prosecretin of the intestinal epithelium either directly or indirectly. One tissue, in other words, through its products of metabolism aids another tissue in the performance of its functional duties.

The term kinase is used at present in animal physiology in connection with two reactions only. In both cases it refers to an activating process similar to those just considered, except that the activator is a colloidal substance of unknown composition. The pancreatic juice poured into the duodenum contains its proteolytic enzyme in the form of a trypsinogen which is activated immediately by trypsin by contact with the duodenal epithelium or with the secretion furnished by this epithelium. The activating substance is designated as enterokinase. It is present normally in the intestinal juice formed in this part of the alimentary canal, or it may be obtained in extracts of the mucous membrane of the duodenum or jejunum. According to Pawlow, however, the intestinal secretion obtained by direct mechanical stimulation of the epithelium is lacking in enterokinase. This latter substance is produced in fact only under the influence of some constituent of the pancreatic juice, possibly the trypsinogen itself. In other words, it would seem that the enterokinase must itself be activated before it can fulfill its functions as an activator of the trypsinogen. The chain of interrelated processes occurring at this point in the act of digestion becomes somewhat intricate as follows: Hydrochloric acid formed in the stomach and brought into the intestine with the chyme stimulates the epithelial cells of the intestine to form secretin and to pass it into the blood. The secretin conveyed by the blood to the pancreas stimulates this organ to secrete pancreatic juice. The pancreatic juice is carried to the duodenum and stimulates the epithelial cells to form enterokinase, which then activates the trypsinogen to trypsin. Assuming that all of these steps are verified by future work, we have in this series of events an excellent example of chemical co-ordination, that is to say, of co-ordination effected by chemical stimuli conveyed from one organ to another through the liquids of the body. It may be noted in passing that the epithelial cells of the duodenum under the influence of acids or soaps form an internal secretion, the secretin, while under the influence of the pancreatic juice they produce an external secretion, the enterokinase. It is of course possible that these two different functions are subserved by separate cells, but so far as our evidence goes at present we must infer rather that one and the same epithelial cell gives either an internal or an external secretion according to the nature of the chemical stimulus acting upon it. While there can be no doubt at all of the existence of enterokinase and of its wonderful effect in activating almost instantaneously the trypsinogen of the pancreatic juice, much uncertainty prevails as to its nature and its mode of action. Pawlow thought that it belongs to the group of enzymes, and this view has been supported in an almost convincing way by the experiments of Bayliss and Starling. In accordance with this view it is found that the substance exhibits a certain degree of [illegible]bility, being destroyed at a temper[illegible] C, although in this respect [illegible] most of the well known enzy[illegible] point the action of the ente[illegible]nogen would come under the gen[illegible] reactions, but here again it is to [illegible]tion differs from that of the other [illegible]apidity with which it is complete[illegible]rable to that of ordinary chem[illegible] observers (Dastre and Stassano, H[illegible] Cohnheim) have contended that [illegible]ites permanently and quantitatively [illegible] trypsinogen after the manner of an amboce[illegible]t to form a new and active compou[illegible] and the whole reaction has been still [illegible] by the discovery (Delezenne) that [illegible]nogen may be activated by calcium salts wi[illegible] the presence of enterokinase. The action of the calcium requires some time for its development, but when it occurs it takes place not gradually but abruptly, just as in the case of the activation produced by enterokinase. The further fact stated by Delezenne that the enterokinase itself needs the presence of calcium salts before it acquires the property of affecting trypsinogen suggests naturally the thought that the action of the enterokinase may be at bottom another case of calcium activation. Pozerski states that in the inactive pancreatic juice obtained by injections of secretin calcium is not present, whereas in the active juice following upon the use of pilocarpin calcium is contained, and the digestive action of the juice runs parallel with the content in calcium. But whether the enterokinase acts as a ferment, or an amboceptor, or a calcium carrier, it constitutes a special type of organic activator, and this fact suggests the possibility that other processes in the body may be controlled by similar compounds. At present only one other organic activator of this kind has been described, namely, the thrombokinase of blood coagulation. This hypothetical substance is given great importance in the theory of coagulation proposed by Morawitz. According to this theory the blood corpuscles under abnormal environment yield an unknown substance of colloidal nature which, together with calcium, is necessary for the complete activation of thrombin, and therefore for the clotting of blood. A similar kinase is furnished by the tissues in general, so that blood escaping from a vessel and coming in contact with the surrounding tissues obtains from them a kinase which accelerates the process of clotting. The evidence for the existence of this kinase is far less satisfactory than in the case of the enterokinase, [illegible]

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* Address of the vice-president and chairman of Section K—Physiology and Experimental Medicine, American Association for the Advancement of Science, Boston, December 29th, 1909.

[illegible] the facts at present warrant the assumption at [illegible] organic kinase must co-operate with the [illegible] in activating the thrombin but if the idea is onstrated to be correct it will furnish another ry interesting example of the way in which chemi l co-ordination may be employed in the body In is case the blood may be supposed to stimulate the ssue cells to form a substance not directly of im rtance to their own activity, but which initiates the agulation of the blood, stops the hemorrhage and us saves the organism from destruction The series events is quite parallel to that described for the ncreatic juice and the enterokinase

In addition to the activators of the inorganic and e colloidal type there is perhaps a third kind of acti ation exemplified in the substances known as co-zymes or co ferments This term may be used to fine that kind of co-operative activity between an zyme and some other noncolloidal substance which e see illustrated in the influence of the bile salts pon pancreatic lipase The process differs from tivation of a proferment to a ferment only in that e combination of the enzyme with its activator is versible instead of being permanent By dialysis otherwise the coenzyme can be separated from the zyme and the action of the two may be tested sepa tely or in combination Perhaps this species of acti ation may be more common in the animal body than e have supposed Bierry and Giaja have shown that e amylase of pancreatic juice loses its diastatic tion entirely when dialyzed and this power or prop ty is restored upon the addition of sodium chloride would seem from their experiments that the amy se is active only when combined with an acid ion ch as Cl or Br and the transition from one form to e other, from the active to the inactive or the re rse, is easily accomplished No one can doubt that l these forms of chemical activation are allied in a neral way to the more interesting and obvious mode chemical co-ordination illustrated by the hormones tarling defines hormones as chemical messengers hich formed in one organ travel in the blood stream other organs of the body and effect correlation be veen the activities of the organ of origin and the gans on which they exert their specific effect Such bstances belong to the crystalloid rather than the lloid class they therefore are thermostable and do ot act as antigens when injected into the living ani al. The general idea of this definition is clear and ost suggestive but in its details [illegible] made especially suit the case of secretion [illegible] may not t so well for other [illegible]gical ilue Conveyance thr[illegible] while rtainly the most comm[illegible] of dies ought not to co[illegible]rt of eir definition The [illegible] intesti al epithelial cell is co[illegible] in the lood and brings about [illegible]he activ y of this gland and [illegible] but on e other hand some [illegible] the pan eatic juice and conve[illegible]m in the ream of secretion exci[illegible]f the en rokinase and thus corr[illegible] the duo enum with that of the [illegible] two actions em to be so similar ex[illegible] of trans rt that one would natur[illegible] in the same ass By the same reaso[illegible] justified designating the hydro[illegible] gastric ice as a hormone in refer[illegible] in caus g a formation of secretin in the epithelial cells of e duodenum One can imagine that a similar trans rtation may occur in the secretions of the reproductive or respiratory passages, in the cerebro-spinal id as seems to be the case for a time at least with e secretion of the pars intermedia of the pituitary and, or even along the axial stream of a nerve fiber , as seems to me, the idea of correlation or co-ordi tion is the essential point rather than the assump on that the product must constitute an internal secretion, we might modify the definition so far as to desig te as hormones those substances in solution which nveyed from one organ to another through any of e liquid media of the body, effect a correlation between the activities of the organ of origin and the gan on which they exert their specific effect As gards the nature of the action of the hormones on e organ affected we know too little to make any fe generalization In the case of the secretin it ems most probable that the hormone arouses the ncreatic cells to an act of secretion, and therefore has in this instance the value of a chemical stimus. But in other cases the effect of the hormone may rather of the nature of an activation This at ast would seem to be true for the hormone of unown nature, given off by the pancreas and concerned the glycolysis of sugar in the organism The effect the hormone adrenalin upon the musculature inrvated by the sympathetic system may also be of e nature of an activation rather than of a chemical [illegible]

The [illegible] of known composition which may be [illegible] the rôle of hormones are few in number three or four at most, as follows First, the carbon dioxide formed in the tissues, particularly in muscle during contraction. It seems agreed now that the carbon dioxide acts as the *normal* stimulus to the respiratory center When produced in the working muscles in such quantities as to raise perceptibly the carbon dioxide tension in the alveoli of the lungs and the blood of the pulmonary veins the respiratory center is excited to greater activity and the excess above the normal contents is thereby removed second the adrenalin of the adrenal glands which in some way directly or indirectly makes possible the full functional activity of the involuntary musculature of the body third the hydrochloric acid produced in the stomach which stimulates the formation of secretion in the duodenal epithelium and fourth possibly the iodothyrin of the thyroid gland with its dynamogenic effect upon the neuro muscular apparatus of the body In addition there are a number of hormones of unknown composition which have been either proved or assumed to exist and which are held responsible for certain well known correlations of function The pancreatic secretin formed in the epithelium of the duodenum or jejunum which stimulates the flow of pancreatic secretion the gastric secretin formed in the pyloric mucous membrane which gives rise to the chemical secretion of gastric juice a secretin formed in the duodenal epithelium which stimulates the formation of intestinal juice in the following segments of the intestine unknown hormones of pancreatic origin which determine the absorption activity of the intestinal epithelium vaso dilator hormones formed in tissues in functional activity and which have a specific effect upon the vessels of the functioning organ a vaso constricting and a diuretic hormon formed in the posterior lobe of the pituitary body a hormone controlling the growth of the bones and connective tissues produced in the anterior lobe of the pituitary body a hormone controlling the oxidation of sugar in the body and produced in the cells of the islands of Langerhans in the pancreas a hormone produced in the thymus which controls possibly in some way the development of the reproductive organs a vaso-constricting hormone formed in the kidneys a hormone in the salivary glands which controls the *flow of water from the* blood capillaries in the glands a hormone produced in the fœtus in utero which stimulates the growth of the mammary glands a hormone in the ovary which controls the growth of the uterus and the processes of menstruation a hormon in the ovary which controls the implantation of the fertilized ovum and the growth of placental tissue a hormone in the testis which initiates the development of the secondary sexual characteristics in the male hormones of an indefinite number produced in all the tissues and acting specifically upon the determinants in the gametes in such a way as to make possible the transmission of acquired characteristics It is evident from this summary that there is a well developed tendency in physiology at the present day to utilize the conception of hormones to explain all relationships not otherwise intelligible A few years ago the number of hypothetical enzymes in the body was likely to be increased whenever a new research in metabolism appeared now the drift seems to be in the direction of manufacturing new hormones This natural inclination to abuse a new and attractive idea will not of course prejudice us against the great importance of the suggestion which we owe to Bayliss and Starling It is to be hoped only that no one will be tempted to give to these hypothetical hormones distinctive names except in cases such as the secretin adrenalin etc in which the substances have been isolated in some degree of purity For once a specific name has become attached to an entirely unknown substance it acquires henceforth an easy currency in our literature and soon many of us unconsciously assume that the thing so designated constitutes one of the verified facts of our science By way of example one may cite the thrombokinase which has become such a familiar term in the literature of coagulation and which not infrequently is employed by writers as though its existence were a settled fact

Among his other valuable suggestions regarding the characteristics of the hormones Starling has called attention to the fact that some of them act by increasing the processes of disassimilation or catabolism while others apparently stimulate the processes of assimilation or growth In this latter group we may include the hormones of the anterior lobe of the pituitary body according to the present conception of the functions of that gland and all of the hormones of the reproductive cells These latter have in general what has been designated as a dynamogenic action they cause hypertrophies in various organs or tissues and invoke therefore processes of synthesis rather than those of splitting and oxidation Hypertrophy as an outcome of increased functional activity is a familiar phenomenon, but as Nussbaum remarks the hypertrophy induced by testicular or ovarian hormones resembles rather the effect of the growth energy exhibited by the developing embryo, in that it is dependent upon influences other than those arising from functional use What these influences may be is at present a matter of pure speculation In his recent most interesting contributions to our knowledge of growth Rubner has been led to assume that the property of growth in the *young* organism is connected with certain special chemical complexes in the protoplasmic material complexes which have nothing directly to do with the simple maintenance of the nutrition of the cell and which after adult life is reached disappear for the most part from the general soma In line with this hypothesis one might assume that the hormones given to the blood by the reproductive cells contain such complexes which when anchored in certain tissues lead to an accelerated growth Perhaps the clearest and most interesting experiments made upon the reproductive hormones are those reported by Nussbaum He chose for his experiments the males of *Rana fusca* whose reproductive organs go through a cyclical period each year At the proper period the preparation for the mating season shows itself in the hypertrophy of the seminal vesicles of the thumb pads and of certain muscles in the forearm If the frog is castrated these hypertrophies do not occur or if they have begun before the castration is performed retrogressive changes take place On the other hand the usual hypertrophy of the nuptial organs can be initiated in a castrated frog if pieces of the testis from another frog are introduced into the dorsal lymph sacs The pieces thus introduced do not become grafted permanently but are gradually absorbed and the growth of the thumb pads and of the muscles in the forearms falls off after this absorption is completed Nussbaum believes that the stimulating effect of the testicular hormones is not exerted directly upon the tissues which show the increased growth but rather upon the portions of the central nervous system which innervate these tissues This belief rests upon the experimental fact that if the peripheral nerves going to the glands and papillæ of the thumb pads are severed on one side the testicular hormone affects only the other intact side This experiment and the conclusion drawn from it opens up the interesting question whether perhaps the reproductive hormones in general exert their effect through the central nervous system This has not been the usual belief and the experiments of Nussbaum are open to the obvious objection that the section of the peripheral nerves may have induced certain secondary changes in metabolism which indirectly antagonized the action of the testicular hormone At present these experiments so far as I know have not been repeated with this objection in mind and it is somewhat gratuitous to criticise the author's conclusions until further work is reported

RUBBER AND FIBER COMBINATION

According to Consul General John L Griffiths a member of a tire company in London has been conducting experiments to produce a rubber compound combining pure rubber with a vegetable substance that will avoid the defects which he thinks are produced by the common method of incorporating mineral substances such as magnesia chalk and oxide of zinc The experiments have developed a process by which the vegetable fiber employed is made to pass through the rubber in all directions in minute threads In this way the rubber and the fiber are caused to act in support of each other with the result that the compound is remarkably tough and retractile and resistant under pressure or tensile strain

A new method of producing nitrogen from the air by combustion has been patented by L F Aumont The invention relates to the separation of nitrogen from atmospheric air by the complete combustion of a combustible gas and the subsequent removal of carbon dioxide and water vapor from the product A suitable apparatus for the purpose comprises a mixing chamber for the gases a combustion grate (cooled if preferred) with narrow openings to prevent the flame striking back into the mixing chamber, and a closed combustion chamber with a suitable arrangement for cooling the burnt gases The combustion may be controlled by the use of an apparatus for automatically determining and recording the proportion of carbon dioxide in the burnt gas and where the composition of the combustible gas is variable an automatic regulator may be introduced this consists of a metal tube filled with copper maintained at about 400 deg C through which a part of the burnt gas is made to pass the tube is connected with one pole of a source of electricity and the copper is connected at various points through the coils of four electro-magnets with the other pole any excess of oxygen reduces the conductivity of the copper by oxidation and causes one or more of the electro-magnets which control the air supply to become inactive A water blast (filter pump) is preferably employed for withdrawing the gases from the combustion chamber this cools the gases and effects the absorption of carbon dioxide therefrom leaving nitrogen to pass on to the receiver.

MEASURING INSTRUMENTS OF LONG AGO.—III.*

THE MECHANICAL APPLICATION OF GEOMETRICAL PRINCIPLES.

BY WILLIAM E. STARK.

Concluded from Supplement No 1796, Page 366

MAP MAKING INSTRUMENTS

Several ingenious instruments were devised especially for taking observations over a considerable area and recording the data in the form of maps In most if not in all cases the map was made *in the field* as in the case of the modern plane table If two points on a sheet of paper are taken to represent two points on the ground the position of a third point may be obtained by transferring to the paper the lines of direction to the third point from the two points of observation with reference to the line between them (Fig XXX) Thus from two stations the relative positions of all points visible from both may be obtained provided the direction lines do not intersect too obliquely If the distance between the points of observation is known any other distance may be taken from the map by scaling

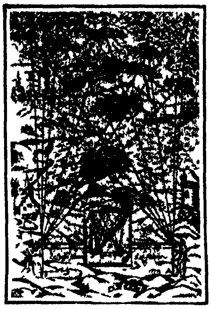

Fig XXX —LOCATING OBJECTS BY OBSERVATION FROM A SINGLE BASE LINE

From [illegible] Fig VIII

In some instruments the directions were obtained with reference to the meridian by use of a magnetic needle Fig XXXI shows a compass described by Bartoli 1589 The vertical circle and alidade enabled the observer to take observations conveniently to points at a different level than his own and when desired to determine the difference of elevation The student should note the error involved when the pivot of the vertical alidade is not exactly horizontal

Fig XXXI —MAGNETIC COMPASS WITH HORIZONTAL AND VERTICAL SIGHTS

From Bartoli See note under Fig XXII

The *trigometre* invented by Philippe Danfrie and described by the inventor in a beautiful little book† published in Paris in 1597 enabled one to read directly from the instrument the distance from either end of the base line to a third point (Fig XXXII) A rectangular bar called the base carried at one end a pivoted rule with sights and a graduated semicircle for measuring the angle between base and rule A second rule was attached to a clamp by means of which its pivoted end could be set at any point on the edge of the base This rule also carried sights and graduated semicircle and both rules and base were marked with similar scales of equal parts

The sight at each pivot could be turned so as to permit sighting either along the base or along one of the rules Both rules could be clamped in any position on their semicircles The whole was mounted on a tripod with adjustable joint for orienting and leveling and carried a magnetic compass

In practice the instrument was set up at the right end of a base line and with the base horizontal and parallel to the base line The right rule was then aimed successively at the various points to be mapped and the angles recorded The instrument was next moved to the other end of the base line and the base set in position by sighting back toward the first station The left rule was now clamped in such a position that the reading on the scale of the base corresponded to the length of the base-line With the right rule clamped at the angle previously recorded in connection with a given object the left rule was aimed at the same object The readings of the rules at their intersection then gave the distances of the object from the ends of the base line For measuring differences of elevation the instrument was set in a vertical plane by means of the adjustable joint A pendulum attached to the right rule was used for setting this vertically

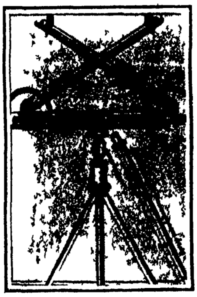

Fig XXXII —DANFRIE'S TRIGOMETER.

Valletto* in a little book published in Venice in 1564 describes an instrument on the same principle as the trigometer which he calls a 'holometro

LEVELING INSTRUMENTS

Inventors of leveling instruments made use of the free surface of a liquid of the plumb line and in the later instruments of the bubble tube Figs A C, and G in Plate XXXIII taken from Bion illustrate the three types Apparently all three were in use when Bion wrote

There were numerous devices for determining a line perpendicular to a plumb-line In a very old† form (Fig XXXIV) a frame like the letter A carries a plumb-line attached to the vertex When the line hangs over the mid point of the cross-bar the feet of the A are in a horizontal line The verification of this relation is a good problem for the beginner In some forms of the instrument marks were placed on the cross bar corresponding to the angle of slope of the line formed by the feet of the A.

Many of the devices already described could be used for projecting a level line for example the geometric square the quadrant and the octant. In all of these the sights could be set at right angles to the plumb-line which was an essential feature of the instrument (Fig XXXV) Some examples of levels of the plumb-line type were designed to give the greatest possible accuracy The instrument (Fig XXXVI) described by Bullet* architect to Louis XIV was in the form of a letter H One of the uprights was hollow and a plumb-line several feet long which was hung inside it was [illegible] glass panel The plumb-line was [illegible] disturbing action of the wind [illegible] of the frame was at least [illegible] sights which determined a line [illegible] reference line ruled at the back of [illegible] A rack on the second upright [illegible] crank pivoted at one end of [illegible] enabled the operator to raise or [illegible] the reference line referred to [illegible] plumb-line An alidade was also [illegible] instrument for measuring by means of [illegible] one of the uprights considerable [illegible] the geometric square A quadrant was [illegible] for measuring vertical angles which, with the aid of a table of sines could be used in place of the vertical scale for determining heights Fig XXXVII shows the instrument in use.

Fig XXXIII.—LEVELING INSTRUMENTS

From Bion

Bion shows (Fig XXXIII *I K L*) a self adjusting level of the plumb-line type a sight being hung from a single support by means of a piece of metal carrying a heavy weight The whole apparatus was so adjusted that the line of sight was perpendicular to a line through the point of support and the center of gravity of the instrument.

Fig. XXXIV.—LEVELING WITH A PLUMB-LEVEL.

From Pomodoro, See note under Fig III.

Special instruments of various forms were invented for the use of artillerists in setting cannon at any desired angle of elevation (Fig XXXVIII,) Such instruments were often combined with scales giving the weight of iron cannon balls corresponding to various diameters or calibers of pieces In this connection a pair of calibet compasses or calipers is shown (Fig XXXVIII, *A*) as an application of the properties of similar triangles, although it has no device for measuring inclination The jaws of the calipers end in a double set of points, the inner pair for use in measuring the diameter of the ball the outer pair, the caliber of the gun The student may show that there will be a constant ratio between these two measurements for all settings of the instrument A metallic finger hinged at about the middle of one arm indicates on a scale on the other the weight of bullet corresponding to the opening of the points

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* School Science and Mathematics

† Declaration de l'Usage du Graphometre Philippe Danfrie Paris, 1597

* Discrittione et Uso dell Holometro By Abel Fullone Valletto Venice, 1564

† E N Legnazzi Del Catasto Romano e di Alcuni Strumenti Antichi di Geodesia. Drucker, Verona, 1887 Plate XVII.

* Traite du Nivellement. Par le sieur Bullet. Architecte du Roy. Paris, 1688.

As stated at the beginning of this article my purpose in describing these old instruments is to suggest applications of mathematical principles which will add to the interest and significance of the formal work of our high school courses I have mentioned only a few class exercises which may be based on this material but I hope that teachers who have felt the need of more concrete illustrations will find many opportunities of using these examples of the applied mathematics of a bygone day

Fig XXXV —LEVELING WITH QUADRANT
From De Judaeis See note under Fig VII

THE RODIYAS: A RACE OF OUTCASTS

There is in Ceylon a community of people who are like the Indian pariahs absolute outcasts from all society They gain their livelihood if they labor at all by the most degraded of work making ropes from the hides of cattle an occupation abhorred from its ancient association with the hangman They also prepare the skins of monkeys for use in making the native drum or tom tom Th[illegible] for these in kind They deposit thei[illegible] the houses of likely purchasers[illegible] skins are needed they are taken[illegible] in their place Naturally [illegible] centuries under a system [illegible] way shameless and brutali[illegible] ve as itinerant beggars The[illegible] de and not ill favored someti[illegible] t light brown complexion T[illegible] of them among the finest speci[illegible] the East They wander about th[illegible] displays of dancing and juggling Their [illegible] ry low

Of late years und[illegible] ment this unhappy tribe has made some [illegible] n material things though the social stigma remains As regards education their condition is deplorable They could no be tolerated in schools along with other children their presence would be an abomination Nor have they had any schools of their own until recent years, when a mission has started work among them Under these circumstances they have had no chance of improvement, they have sunk lower generation after generation But now it is the intention of the government to make a determined effort to raise them Their children are to be educated in properly organized schools established in their villages. They are to be given opportunities of becoming landed proprietors, and efforts are to be made to teach them agriculture They are to be taught trades, too and markets are to be found for what they produce

Fig XXXVI —INSTRUMENT FOR LEVELING
From Traite du Nivellement by Bullet, Paris 1688,

The origin of the Rodiyas is lost in obscurity Popular tradition among the Sinhalese states that they are the descendants of royal huntsmen who were banished and degraded for an abominable crime they served up human flesh before the king on a day when they had been unsuccessful in the chase There is no reason to think that this story is anything more than a myth, having its source in a natural tendency to assume a terrible cause for so terrible an effect Brahminical influences must not be lost sight of Among Orientals in whose philosophy life was all misery and death a happy escape the extreme form of punishment would not be death but a continuance of life under conditions which should add to its misery by every conceivable means So the Rodiyas would be the descendants of people condemned for various crimes to this form of punishment and their ranks would be added to from time to time There are moreover authentic records of cases where offenders guilty of high treason and similar crimes were cast out by the kings of Kandy to join the Rodiyas their wives and families being cast out with them This would explain the fine physique of this people and the good looks of their women for some of the best blood of Ceylon must flow in their veins recruited as they have been from the ranks of treasonable nobles and fair but frail princesses It has been thought on the other hand that the Rodiyas are the representatives of some foreign race oppressed and degraded by their conquerors There is in fact a reference in the Mahawanso the Sinhalese history of Ceylon to a village of outcasts in Ceylon in the fifth century A D of Hindu origin and it is supposed that these people had immigrated from the coast of India and were of Chandala blood a tribe so degraded that their shadow was pollution So far however as physical tests are concerned there seems little to distinguish the Rodiyas from the rest of the Sinhalese while their language only differs in a few words peculiar to it which approximate mainly to the Gipsy tongue and it is easy to understand how an outcast people woud pick up many words from a wandering tribe like the Gipsies

In considering the origin of the Rodiyas one can not but be struck by the strange resemblance between their position in Ceylon and that of the Cagots and Caqueux in the Pyrenees and in the plains of Bretagne Poitou and Guienne There is hardly a point in which they differ The Cagots and Caqueux dared not draw water from a public well or touch the parapet of a bridge with the bare hand their persons were contaminating they had to wear shoes to protect the earth from pollution and they bore a red mark on the shoulder to warn travelers of their identity Though allowed to become Christians they had a separate entrance to the church a separate bowl of holy water and a separate burial ground Their descent is equally uncertain it is thought by some that they were sprung from Gothic or Moorish oppressors overcome and expelled from the pale of society for their past enormities by others that they were representatives of alien religions Arians Jews or Mohammedans and loathed and abhorred on that account from times when religious toleration was inconceivable There is no proof in either direction but there is one striking similarity between them and the Rodiyas which suggests a like origin for both Western and Eastern pariah As I have said we find the Rodiyas engaged in making ropes from hides of cattle an occupation held in particular abhorrence from its association with the hangman In the same way the Gagots were carpenters and the Caqueux were ropemakers and both trades were alike infamous at an early period because the carpenter furnished the gibbet and the ropemaker the halter for the executioner This fact supports the idea that the origin of the loathing in which these people were all held may be found in this association between them and the hangman Now it is a fact that in the times of the Sinhalese kings executioners were always drawn from one class—namely that degraded section of the community known as Candalas This class may be connected with the Candalas of India mentioned in the Mahawanso that it was a most degraded society is certain There was at a late date some confusion between the two classes the Candalas and the Rodiyas and the term Candala is sometimes used in the sense of Rodiya. The Rodiyas however occupied a position inferior to the Candalas and seem to have been attached to them as servants One indication of that is to be found in the fact that, while the Candalas are extinct by absorption into the surrounding peoples the Rodiyas still exist as a distinct tribe too low to have any hope of absorption The Rodiyas would naturally in their capacity as servants be the makers of the ropes which the Candala executioner used for his opprobrious trade and would be the objects of an even greater contempt than that with which their masters were regarded Some such origin as this for the degradation of the Rodiyas seems most probable—it accounts not only for the intensity but for the persistence of the loathing with which the tribe was regarded —G F Plant (Ceylon Civil Service) in the Manchester Guardian

A NOVEL RADIOMETER.

A simple and novel radiometer has been devised by Mr R H Smith an English inventor for measuring the amount of radiation falling upon and absorbed by a black rough dull surface The radiant energy absorbed takes the form of heat which is immediately conducted to water flowing slowly through a small tube and the rise of temperature of which is measured The principles on which the apparatus is designed are first the use of a very large absorbing surface—one square foot Second the proportionment of the water flow to the rise of temperature so that the percentage of error in each of the two measurements is about the same and third the raising of the temperature of the receptive surface so slightly that its loss of heat by radiation is unappreciably small Under different conditions of the use to which the instrument has so far been applied namely the testing of open fires and other house heating arrangements the proper flow of water varies from 0 375 to 0 75 pound per minute and the rise of temperature from 6 to 10 deg F The thermometers are graduated to one tenth deg C or one fifth deg F Practically the whole of the heat received is collected in the water and 0 [illegible] per cent accuracy in its measurement is easily attainable

Fig XXXVII —USE OF BULLET S LEVEL.
See Fig XXXVI

The surface is composed of a coil of small extremely thin copper tubes measuring over 50 feet in length through the extent of which water flows by gravity under a head which is kept constant during each test but which can be varied according to the intensity of the radiation to be tested The square tube forms a complete unbroken flat surface The water flow is accurately measured by weighing the water collected every five minutes It can be measured more quickly and easily volumetrically in an eudiometer

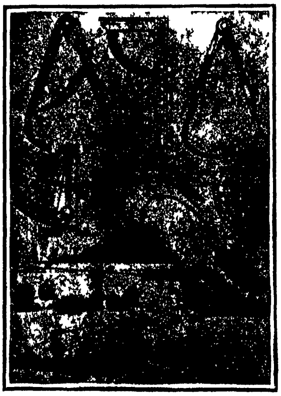
Fig XXXVIII —ARTILLERIST S INSTRUMENT
From Sion

The receptive surface of copper tube is carefully shielded from any cooling by convective air currents by a protruding open box in front and by a closed hollow non-conducting box behind The sides of the front shield are of thin good-conducting metal and are blackened both internally and externally Nevertheless it is advisable to place the instrument at not less than 6 feet from the source of radiation in order to secure an approximately parallel radiation falling upon it.

The sensitiveness of the instrument has been illustrated by placing a two-inch cube of fresh black coal upon a large open bright fire in a grate measuring 24 by 13 inches with 7 to 8 inches depth of fuel and the indicated radiation has changed sensibly in one minute.

There is considerable viscous and frictional resistance to the passage of the water even at the slow rates of flow used through the long length of small tube and the work done in overcoming this resistance eventually appears as heat in the water. But this amount of heat is not more than about one-hundredth of one per cent of the whole heat measured. This consideration points to keeping the water flow as low as possible consistent with avoiding a too high rise of temperature.

TAILS AND THEIR USES.*

WHY NATURE CREATED CAUDAL APPENDAGES.

BY JAMES NEWTON BASKETT.

We are very apt to regard the tail as merely the other end of the body but nature seems to have early esteemed the member and made it her most efficient implement of locomotion. The fish forms are propelled almost wholly by it and as a distinct part of the backboned body it is really older than the head and was the first part of the spine to be vertebrated if we are to heed the suggestions of embryology and paleontology.

Below the vertebrates it had become a great tool for the crustaceans of which the lobster and the crawfish are types shot backward by means of this wonderful propeller and here it took on early the form of a hand or clasper since the mother articulate when she walked out on dry land at least in passing from swamp to swamp carried then as now doubtless her eggs or young under the grasp of this terminal flipper. Among the insects closely related the tail is interesting as a support for various implements useful in their economy such as stings ovipositors and pincers. The first two are common and the last may be seen on the end of the male dragon fly whereby he clasps the slender neck of his mate and steadies her while she with much effort thrusts her ovipositor into a tough reed stem. This is a case where there are two remarkable terminal implements in the family. Perhaps no more delicate contrivance is found in nature than the cluster of spinnerets found on the caudal extremity of the spiders.

THE FISH'S TAIL

Among the vertebrates the tail reached its perfection as an essential in the fishes where as noted it is almost solely the means of motion for the fins are largely balancing members. The terminal fringe is without doubt the parent of the upper and lower unpaired fins and it is not improbable that the paired fins came out of it also. If this be true the legs of the quadruped had their origin here and the human hand may have been cradled with the caudal fin among the rushes.

The shape and other characteristics of the tail fin may tell much of a fish's ancestry and modern habits but further discussion of this is precluded here more than to say that those swimmers with tails widely forked are apt to be more speedy and game than those with square or rounded tails as any one may recall who has had the mud cat and the channel cat on his line. The higher fishes have the tail stuck straight into the fringe but those of the shark tribe have it turned up within the fin like a sled runner, and usually their upper lobe or fork is the longer. This is so exaggerated in one shark called the thresher that while lying on the surface it can thresh or strike the whale well up on his great sides and an attack of a few of such lambasters is said to prove fatal to the leviathan at times. The tails of fishes usually give beauty and symmetry to the body but they are much modified and the great sunfish of the sea has no tail proper but is merely fringed on the blunt rear end of the body. Among the skates and rays the tail is round and quite unfishlike and the sting ray has two spines on it secreting an acid fluid around them. By these there may be inflicted a painful wound.

THE TAIL SALUTATION

Among the peculiar tailed fishes the sea horses are alone in having the tail prehensile. With it they anchor themselves to seaweed and other things in strong currents for they are poor swimmers. Here too is the first manifestation of the emotions by means of the vertebrate tail for as two of these interesting creatures meet they may clasp tails for a moment and then pass on as if they had wished each other well. They have thus antedated our handshake a few cycles.

The water haunting members of the amphibians to which the mud puppies salamanders efts and frogs belong retain the tail somewhat flattened as a swimming member, while with those which are more land haunting it is round. As is well known the frogs when grown dispense with it as a hindrance in leaping and it is the first creature in the vertebrate scale to lose every external vestige of this member and to dispense wholly with its uses. The absorption of the tail in frogs and toads is the most interesting biological process known to take place after the creature has left the egg and the loss even before hatching in some forms adds a factor of study of more interest than those exhibited by the usual tadpole. Some frogs are hatched tailless—the tail being fully formed in the egg but absorbed before coming forth.

QUEER USE OF THE TAIL

We have seen that up to this time the tail had few uses beyond that of action and some modification as a weapon. The reptiles cultivated all this more extensively and introduced some novel practices with this member. In the first place besides paddling or sculling with it in the usual way when they went into the water they used it as a rudder in flying and later made it help spread a membrane for gliding on the air. On one of these old skin flyers the tail was a long affair with a stem and a racket shaped expansion at the tip which steadied his aerial gait in a manner not unlike the rudder of the modern aeroplane. But among the reptiles only is the tail used as a prepaid ransom or a sacrificial offering. Many of the lizards have the organ so feebly connected up as to break off easily if it be pulled at as the creature tries to escape and the owner is thus able to go maimed into safety rather than remain whole in the stomach of the enemy. Thus our little so-called glass snake which is not a snake at all but a legless lizard found in Missouri and southward has such a tail in great perfection. Between the joints of the vertebræ run gristly septums or disks and these extend through the skin. They adhere so slightly to the tissues which they touch that the exertions of the lizard itself in a sudden attempt at escape may break the tail and a slight blow with a switch at the joints causes fracture. The wiggling remnant is such an attractive tidbit to the pursuer that he may allow the body to go. Indeed the owner itself has been known to turn and swallow its own extremity perhaps without knowing what it is. For these reasons this lizard is in some regions called the jointed snake. The parts never reassemble as is popularly claimed but the creature can grow a new tail. It is not however so well shaped as the old one. In this connection it may be said that the ready manner in which the skin slips on the tails of many of the rodents seems to imply some similar purpose and the tail features of birds are always loosely set for the same reason. The squirrel very consciously puts his tail between his body and an expected danger explores scary places with it stuck out well in front of him and curls it over his back when he eats as much as a shield as an ornament. In all these cases his hope is that if the enemy make a dash the tail may be grasped and the body missed his worst foe being usually the hawk above him.

AS A MEANS OF SUPPORT

Besides its aid in flying the reptiles first used the tail as a balancing member and as a fifth leg when sitting up bipedally. The old fossil monsters so braced themselves while resting and such as walked like birds, and made those celebrated birdlike tracks in the Connecticut Valley, may have used it as a balancing pole as they strode. One little modern lizard called the frilled lizard so uses it now, when he gets good and angry and struts away with only his toes touching the floor while the tail is stuck out far behind as a stiff poise. Of course many quadrupeds higher up the scale sit erect by the use of the tail as a prop, notably the kangaroo. Excepting the case of the seahorse noted the reptiles first used the tail prehensilely. The tree lizards many of the snakes and the true chameleon (not the little aneolis of the South, so called) grasp well with the tail. One snake has the honor of having the only tail in nature specifically shaped and armed for burrowing. On the "shield tail" the body ends squarely and there is a horny, flat shield across the frustum by which the creature pushes itself into soft earth. The tails of some other snakes however have horny tips to aid in burrowing, among which is our common pine snake.

AS A MUSICAL INSTRUMENT

The snakes have the honor of first ma[illegible] a musical instrument for more than one of [illegible] tips may vibrate in anger against dead lea[illegible], to make a whirring sound of bluff or threa[illegible] been thought by some students that this is done in conscious imitation of the peculiar sound of the rattlesnake but it is more likely that the latter's melody is only a greater development of musical talent on a much superior instrument. At least this is the apparent history of the development of most other peculiar endowments. By some lucky means he was not able to complete his moult and portions of his old skin remained after each shedding till he found a toy which became useful as a means of safety and persisted because of such purpose. Just what use a turtle has for a tail we cannot see but it seems to remain as a vestige of a time when it was useful. That of the snapper has blunt spines or buttons on top of it hinting a time when his ancestors used it as a weapon, just as the back buttons on our dress coats hint the time when our ancestors wore swords. Some of the most formidable creatures ever known especially for defense were the old fossil reptiles on the terribly muscled tails of which scores of feet long were fearful three pointed spines. The alligator faintly keeps up the reputation of the family in this respect, and the monitor lizards strike a stinging lash with their whip like tails.

[illegible]LS OF BIRDS

[illegible] now are just a little bunch of [illegible]ricately muscled, into which fea[illegible] is by these latter that we esti[illegible]ity. But the early fossil birds [illegible] tails out of the slight tissue[illegible] scantly stuck on each side li[illegible]. Such tails minus the feather[illegible]om their ancestors the reptiles [illegible] jammed up short and carry [illegible]ely ornamental. The story of [illegible]most a treatise, for nature has [illegible] in form, structure color, and extent of [illegible] tail of the peacock is only a long tuft of [illegible] growing from the back and is supported by the brief true tail beneath.

The bird's tail is not so useful in flight as is usually supposed and while one suddenly deprived of it may fly awkwardly at first he soon adjusts himself to the new conditions. It is only slightly used as a sidewise rudder notwithstanding the frequent assertion of even fairly good observers and is not essential to guiding or rapid turning. Some of the birds and flyers that take insects most expertly in the air have short tails such as bats and swifts and hawks, and those with long tails are by no means among the great pursuers. In alighting, in stopping suddenly in any up and down motion and in balancing while sailing the bird's tail has its greatest use and it began its career evidently as a kitelike surface in rising and sailing down while the legs of the first bird known were made broad by similar horizontal feathers for the same evident purpose. In a few birds now, such as woodpecks, swifts, etc the tail is used as a prop.

Among the group of quadruped animals known as mammals the tail has reached its most interesting and varied uses. It may be a weapon, a bed, a coverlet a respirator, a finger or hand a probe, a shield an umbrella and a whole vocabulary of emotions. The long tailed monkeys balance by it, and one is said to sleep hanging by it; mother monkeys and opossums support their young with it, as these sport on the maternal back, the kinkajou (a coon form) coils it like a rope beneath him and lies upon it, the foxes, coons, lemurs and others cover the thinly clad parts with it during rest and thrust the nose into it as a respirator during sleep; the great anteater walks abroad more comfortably in the hot South American sun under the shadow of it, the "beasts of the field" fight flies successfully with its fierce lash, and the leviathans of the water propel themselves forcibly by it, as may be seen in the whale tribe, the seacow forms, and to a [illegible] extent among the seals. In [illegible] of these [illegible]

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* St. Louis Daily Globe Democrat

[illegible] bats it is used to spread a membrane upon, by which it is tied to the rear legs, and in these it again becomes a factor of flight.

A MEANS OF DEFENSE

Among the uses of the tail as a means of defense, that of the American porcupine is unique Here is the only place where there is a detachable secondary weapon on this member, for its quills come loose readily, and the creature makes a conscious threat and stroke, for the purpose of driving them into the enemy In fact there is a creditable record of these quills flying off from a flip of the tail and striking a piece of hardwood with a force sufficient to remain sticking into it like an arrow If this habit were usual or more than accidental, this would be the first use in the scale of beings where a mechanical projectile was used—at least by the tail One of the fishes brings down flies by shooting a jet of water and the conventional monkey hurls cocoanuts of course

The porcupine waves its tail threateningly when disturbed, knowing the power of this armament It is said by foresters that if the tail of one be chopped off as he sits lengthwise of a limb he will remain in this spot indefinitely seeming not to know how to proceed without this important adjunct Nowhere is the tail used more as a threatening or bluffing member than among mammals as may be seen in the cat tribe and many others By it all felines seem to express a sort of diabolic delight as they are creeping upon their prey and all tend to lash their sides with it in rage Here also the tail is used extensively as a larder or a place to store fat in for consumption in winter stress or summer droughts In lemurs there are reservoirs of fat at the root of the tail and a certain sheep among the Hottentots is well known to have a fat tail of such value that the owners make the animals a little wagon to haul the precious part around with that it may not be bruised on the rocks This is the greatest use that the beaver has for his extensive thick caudal member—to live off in winter It is by no means his trowel as some of us were taught in our readers but it is useful in sudden diving though not necessary An incidental use of it is in warning his fellows of approaching danger by making a resounding slap with it on the water as he goes under

THE WHITE FEATHER

Dr A R Wallace in his remarkable theory of signal or banner colors has shown that a sort of unconscious altruism may be marked upon the tails of birds and mammals which makes each of those that are social something of his brother's keeper at least mechanically It is certainly a noticeable fact to any student that many flocking or fleeing gregarious creatures are apt to display certain conspicuous spots on their rear parts such as bands or blotches when they attempt to escape Some of these may be in plain sight all the time and others will be hidden when the creature is at rest In some as the birds the act of flight will display such as wing bars, white rump spots, or white feathers in the tail which are wholly covered up when perching Our common little snowbird (junco) furnishes a striking example and even the white wing bar of the house sparrow is such a mark

On the snowbird the white feather is on the outer margin and wholly hidden when at rest for the evident purpose of not making the bird conspicuous then but when those of the flock that are first alarmed or are the strongest take flight this white signal furnishes a guide to those that should follow This display in fright and flight is where we get our phrase of showing the white feather

In like manner the tails of many mammals are white below and not above Thus the deer and the hare hoist a white flag when they run and not when at rest Some hares do not have this arrangement and show that they are further away from their ancestors among the social habits Deer and antelope may have this form of tail because they make for safety more by flight than do the cow kind and for this reason their tails are shortened There is much that is plausible in this theory of Wallace and it makes every tail interesting as like a blessing it takes its flight Tails as well as tales may tell much of history and they have in them more than is usually dreamt of in our philosophy A proper elucidation of all pertaining to their discussion would make a treatise

THE PLANET MERCURY.

RECENT OBSERVATIONS.

BY W. F. DENNING, F.R.A.S.

Mercury, the smallest of the primary planets and the most difficult to observe satisfactorily seems to have been neglected by the majority of telescopic students They regard it as an [illegible] not only seldom visible but one which holds [illegible] prospect for successful research But thi[illegible]vedly claim more attention for [illegible] require settlement There [illegible] of fairly definite outline pr[illegible] they are however, very seld[illegible] owing to the small and flutter[illegible] of examination the planet [illegible] the horizon and the disk [illegible] in diameter A pretty hig[illegible] found anything below 200 i[illegible] best

It is, perhaps, surp[illegible] efforts are not made to over[illegible] obtaining a far more complete [illegible] of Mercury and his tele[illegible] already possess The exact [illegible] period remains a mystery and [illegible] that the planet turns on his axis [illegible] the period (eighty eight days) of h[illegible] round the sun remains yet to be disposed [illegible], indeed the supposition is actually incorrect as it probably is

Observations of Mercury may be of great value to settle this and other questions concerning his physical condition Yet though the prospect is so inviting as regards possible consequences of extreme and lasting importance, we find telescopes are employed upon Mars Jupiter and Saturn which have already been thoroughly studied and in regard to which there is a poor outlook in respect to any unique or very significant results In spite of the difficulties attending the telescopic scrutiny of Mercury this planet therefore, deserves careful examination, and it is hoped that this will be realized in the immediate future

I have obtained the most satisfactory views of Mercury at the morning apparitions Picking up the planet about an hour before sunrise, I have kept the object under observation for two hours or more, and found that at sunrise the definition was remarkably good—in fact, good views can be obtained until an hour after sunrise, the increasing altitude of the object compensating for the fainter aspect of the image

Schiaparelli preferred observations made in the daytime, and under conditions which many of us would consider detrimental. One of his best drawings was secured when Mercury was only 3 deg from the sun's limb, the diameter of the planet being then between 4 seconds and 5 seconds. His researches led him to conclude that Mercury had a very dense and imperfectly transparent atmosphere, and that the spots which appeared as very faint, darkish streaks of a reddish-brown color were invariably the same both in position and figure

[illegible] appears to have been the first to discern [illegible] markings on Mercury, and to give a value for the rotation period Harding and Bessel supported his deduction that the planet rotated in a period slightly exceeding twenty four hours and Mr McHarg has quite recently corroborated this value From some observations which I secured in 1906 compared with drawings by Molesworth and others I was led to favor a period of 24 hours 12 minutes but could not absolutely rely upon the accuracy of the figures The investigation is one which obviously demands further attention I am convinced that the surface spots on Mercury are sufficiently definite to enable their apparent motion to be pretty exactly determined but the telescope must be large enough to adequately grasp planetary detail *and all the conditions must be favorable* Having compared a large number of telescopes as regards their performance on the planets I should not care to rely upon any aperture of less than 6 inches and should prefer one of about 10 inches I have seldom seen the disk of Mercury sharply defined when less than 20 deg in altitude

Two views of Mercury were obtained with the help of a 10 inch reflector power 310

Mars is not the only celestial orb on which canals are supposed to have been seen for Professor Lowell ascribes to Mercury a somewhat similar configuration and his drawings appear in Monthly Notices LVII p 148 Like the canals on Venus however those of Mercury have been discarded in recent years for they obviously had their origin in an optical illusion which *ought to have been discovered at the moment the* observations were made

In 1896 and other years Leo Brenner with a 7 inch o g saw many spots on Mercury and gave the rotation period as [illegible]75 days The late Major Molesworth at Ceylon saw many markings on Mercury with a 12½ inch Calver reflector and for a brief résumé of his and other observations see Observatory for September, October and November, 1906

In 1900 Mercury was carefully examined by Prof Barnard with the great 40 inch refractor of the Yerkes Observatory He could see nothing whatever of the canal system of markings represented by Professor Lowell but says that on August 31st 1900 the planet showed quite distinctly marked details There were three or four large dark spots very much resembling those seen on the moon with the naked eye

Many other observers have distinguished the spots I regarded them as similar to the features on Mars in November 1882 Mr McHarg has followed up observations of this planet with great success and diligence, but some doubts may be entertained as to whether his small refractor is a thoroughly capable instrument in observations of planetary detail Schiaparelli, however, who used an 8½ inch refractor in 1882, and an 18 inch in his later researches says that the larger instrument had no advantage over the smaller one The exhaustive character of the eminent Italian's studies of Mercury may be judged from the fact that he made [illegible]0 drawings in 1882 and 1883

Naked eye observations of Mercury often form the earliest efforts of the astronomical beginner and success encourages him to attempt more difficult ones Humboldt Arago Smyth and others aver that Copernicus lamented his inability to catch a glimpse of Mercury and perhaps the statement has stimulated tyros to perform a feat beyond the powers of the greatest astronomer of the sixteenth century But the incident related of Copernicus is questionable In discussing the motions of Mercury he availed himself of observations made at places where clearer skies prevailed than in his own district at Thorn on the border *of the River Vistula where frequent fogs obscured* objects at low altitudes He does not appear however to have definitely complained of failure in picking up the planet The rapid difference in phase near the times of his greatest elongations makes Mercury apparently more brilliant in the spring months *before* the date of maximum elongation and in the summer and autumn months *after* similar dates Thus in 1910 the planet was brighter at the end of April than after May 2nd (date of E elongation) and will be brighter early in September than before August 30th (date of W elongation)

Mercury would be quite a brilliant object were the reflecting power of his atmosphere equal to that of certain other planets Proctor showed that if Mercury possessed the same reflecting capacity as Jupiter *the former ought to shine when in perihelion and at* greatest elongation with twice the apparent brightness of Jupiter under the best aspect

I have found that Mercury usually becomes visible when the conditions are favorable about an hour after sunset and attains his greatest luster about half an hour before he sets The planet may be detected about fifteen times in a year in our climate but this visibility being largely dependent upon atmospheric conditions he is seen in certain years more often than in others In May 1876, I saw Mercury with the naked eye on thirteen evenings, though several opportunities were neglected In May 1909 Miss Irene Warner saw the planet on fourteen occasions He shines with a rosy flashing light and is frequently quite a bright object in a suitably transparent sky His star like scintillations have *often caused him to be mistaken* for a star for they are in remarkable contrast to the steady luster of Jupiter and Saturn Atmospheric undulations act upon the small disk of Mercury almost as effectually as they do upon stellar objects

Mercury was strikingly displayed in the evening sky at the end of April setting, as he did about two hours after the sun It is to be hoped that both naked eye and telescopic observations were obtained in abundance and that our knowledge of this very interesting object will be so much increased as to render the evening apparition of 1910 a really memorable one —English Mechanic and World of Science

ELECTRICAL NOTES.

The Hydro-electric Commission of Ontario who have charge of the construction and operation of the electric power transmission system from Niagara Falls have decided to use aluminium instead of copper conductors and have placed an order for 1 500 000 pounds of aluminium wire

There is no branch of industry to which electricity by its flexibility and its general convenience in confined spaces more readily commends itself than to mining work of all kinds Almost every week states the Electrical Engineer there are extensions to electric plants in collieries At the Canonbie Colliery Dumfriesshire the Duke of Buccleuch has just had carried out an important series of improvements the object of which is to recover the good coal below the level of the pit bottom which had to be abandoned twenty or thirty years ago owing to the lack of mechanical means of haulage and pumping water The works now erected include a vertical high speed engine with a direct-coupled dynamo running at 550 revolutions per minute It develops 87 amperes at a pressure of 500 volts The current is carried down the shaft by double armored special conductors to a distance of 600 yards and drives a haulage which brings the coal up in rakes to the level of the pit bottom from whence it is conveyed by horses An electrically driven three-throw pump deals with the water

An article in the Electrical World by Prof E B Rosa gives an account of the work of the International Committee which is to carry on the work of the International Conference on Electric Units and Standards held in London in 1908 The committee arrived at the conclusion that it was impossible to select a more exact value of the Weston normal cell in terms of the ohm and ampere than had been done by the London conference nor would it be possible to agree upon the specifications of the silver voltameter without further experimental investigation and in response to an offer from Prof S W Stratton director of the Bureau of Standards it was decided that a joint investigation should be carried out there by representatives of that body with a delegate from the Physikalisch Technische Reichsanstalt Berlin one from the National Physical Laboratory London and one from the Laboratoire Central d Electricité Paris These delegates as appointed by the directors of the several institutions are Prof Dr W Jaeger Mr F E Smith and Prof F Laporte The representatives of the Bureau of Standards are Prof E B Rosa and Dr F A Wolff In addition to the work on standard cells and the silver voltameter a comparison is to be made of the resistance standards of the several national standardizing institutions The European delegates have now been in America for some weeks and it is hoped that the investigations will be completed in about two months

In the Transactions of the Faraday Society there appears a paper by W W Haldane Gee and W Harrison on an electrical theory of dyeing The basis of the theory is that any two substances placed in contact are oppositely electrified In tinctorial processes one substance is a non conducting solid and the other a liquid and there is no direct method of determining the potential differences The methods employed in the deduction of the differences in potential between a liquid and a porous diaphragm are mentioned and their suitability for the investigation of dyeing phenomena is discussed The electrical charges of a number of substances in contact with water were determined by the U tube method of Hardy or by the aid of the ultra-microscope and the results show that in a colloidal condition or in the form of a fine suspension substances which are basic in character (basic dy stuffs aluminium and magnesium hydroxides etc) are positively charged while negative charges are carried by substances of acid character (acid dyestuffs silica tannic acid etc) and such substances as rubber latex soap sulphur paraffin wax beeswax starch etc The average value of the potential difference with cotton and water is found to be 0 06 volt with silk and water 0 22 volt and with wool and water 0 91 volt The views of Pelet Jolivet and Wild and Knecht and Batey that dyestuffs are electrolytes and that ionization is increased by dilution and rise of temperature are supported Wool and silk becoming negatively charged in contact with water it is natural that basic dyestuffs (which carry a positive charge) should be capable of dyeing them from neutral solutions but that when by the addition of acid the electrical condition of the fiber is changed (becoming positive) the affinity for these dyestuffs is diminished and that the power of fixing the predominant negative ions of acid dyestuffs is increased In the general conclusions it is stated that although the electrical theory explains why one type of coloring matter is selected by the fiber in preference to another the method of fixation is still a matter of doubt A table is given showing the laws of contact electricity colloidal coagulation, dyeing and capillary ascension in absorbent materials and some effects of temperature

ENGINEERING NOTES.

A large number of tests on the mechanical properties of soldered copper joints have been made with a view to determining the effect of the various processes involved on the strength of the joint and of the copper itself The effect of rolling the sheet into tubes is to increase the limit of elasticity and decrease the elongation but this effect is practically removed by the heating during soldering By drawing the tube after the joint has been made the mechanical properties are improved this effect being particularly noticeable in tubes made from thin sheets Annealing completely removes the increase in elastic limits Thick walled tubes show a greater tendency to break at the joint than thin tubes Tests made at elevated temperatures show that there is very little effect on the elastic limit of the annealed unsoldered materials up to 400 deg C The elastic limit of the unannealed specimens and the tenacity of all the samples decrease with increase of temperature A decrease of elongation is specially noticeable between 200 deg and 300 deg C Drawing the tube subsequent to the soldering appears to favorably influence the strength of the joint and the effect of cold working appears to persist at higher temperatures

A very successful method of ventilating freight and passenger cars has been devised by Mr T H Garland supervisor of refrigerator traffic on the Chicago Burlington and Quincy Railroad The principle of the ejector has been made use of to promote the circulation of air in cars On the passenger car the ventilator is placed on the roof and opens into the deck light or clerestory window Air entering the intake pipes when the train is in motion is deflected through a right angle and is blown out of the ventilator again drawing with it air that is in the car It is said that the amount of air taken out by each ventilator is 400 cubic feet a minute When applied to a sleeping car a duct is run down to some convenient place in the neighborhood of each lower berth and in this way there is a constant but mild movement of air from the lower levels in the car

Bulletin No 36 of the University of Illinois consists of a paper on The Thermal Conductivity of Fire-clay at High Temperatures by Messrs J K Clement and W L Egy The fire-clay specimens are cylinders 40 centimeters long 12 centimeters in diameter with a hole through the center 3 5 centimeters in diameter for the reception of a heating coil of nickel wire wound on a porcelain tube The cylinders are further provided with two long holes 3 millimeters in diameter parallel to the axis and extending to the central plane Through these pass the platinum platinum rhodium thermocouples by means of which the temperatures at two points of the central plane are determined The specimens are inclosed in a fire-clay furnace which has an internal diameter slightly greater than the external diameter of the specimens The heating current is measured by means of a Weston voltmeter and shunt and the thermocouples standardized by means of zinc silver or copper melted in a carbon crucible in a special furnace The electromotive force of the couple is measured by potentiometer and galvanometer Two samples gave constant heat conductivities of 0 0026 and 0 0036 respectively between 300 deg C and 800 deg C one other increased from 0 0021 at 300 deg C to 0 0023 at 700 deg C while a fourth increased from 0 0024 at 400 deg C to 0 0026 at 800 deg C

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Professor Manning the leading American authority on the subject of the Fourth Dimension, contributes an introduction in which he explains how the concept of the Fourth Dimension gained mathematical prominence, and swiftly reviews the work that has been done in the field. He has also edited the essays and supplied explanatory footnotes where required

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TRADE NOTES AND FORMULÆ.

Metals, especially silver, can be colored black by rubbing with a cloth moistened with linseed oil varnish and dipped into finely washed graphite Red ferric oxide (bloodstone) can be added to vary the shade Aging or antique finish of silver is done by rubbing it with a mixture of 6 parts of graphite, 1 of bloodstone or red ocher, with a cloth dipped in turpentine oil

Ultramarine Green (J Rhein)—Coat the object with a copal lacquer containing little oil and brush over the whole surface or any special part of it which is to be bronzed with ultramarine green bronze using a hair brush but not moistening it in turpentine oil Let the object dry slowly in a place free from dust, and if the bronzing is good it may then be glazed A good effect is produced by penciling the raised parts with gold or silver bronze or gilding special parts with leaf gold

A Beutiful Copper Bronze (J Rhein.)—With each gill (¼ quart) of siccative mix about 20 drops of raw linseed oil coat the object with this mixture and bronze with copper bronze to which has been added a little red cinnabar (vermilion) Do not moisten the brush which should be a hair pencil in turpentine oil but use it dry The bronze powder and the cinnabar must of course be very thoroughly mixed Take up but very little bronze on the brush at a time Repeat the bronzing several times until the desired luster has been obtained then let the object dry slowly and glaze with reddish brown spirit lacquer

A Very Fine Brown for Smooth or Partially Smooth Surface.—Give the object a thin even coating of copal lacquer with an otter s hair brush if there are raised decorations bronze these heavily with pure copper bronze and the hollows whether smooth or ornamental with copper bronze to which a considerable amount of graphite has been added Put on the latter with a dry brush Dry the object then coat over carefully with copal lacquer and bronze the whole surface lightly with copper bronze, and dry well Coat over the bronzing with wax dissolved in turpentine oil and polish with wash leather If the color is too light brush with graphite before applying the wax

Hardening of Plaster.—To impart greater hardness to plaster borax should be added to it Plaster to which borax has been added it is true sets slowly but [illegible] exceedingly hard If freshly [illegible] plaster is mixed with alum [illegible] to 1 part alum) poured out [illegible] after drying ground and [illegible] dark red heat the pieces [illegible] appearance and can be easily [illegible] plaster thus pulverized is mixed [illegible] the proportion of 1 to 3 the [illegible] and assume the appearance [illegible] remains fluid longer than ordinary [illegible] work and generates no air bubbles [illegible] hour the mixture hardens From [illegible] gypsum also a plaster mass that quickly becomes very hard may be prepared For this [illegible] dissolve in 100 parts of the water required [illegible] 16 parts of sal ammoniac and 16 parts [illegible] The mass after mixing does not harden any more quickly than the burned alum gypsum but becomes just as hard as this In mixing the plaster only enough water should be used to form a thin paste care must also be taken that the mixing water and the plaster are of about equal temperature Good fresh plaster should not lie heavy at the bottom on mixing It should combine evenly and slowly with the water forming no lumps and in setting it should become evidently warm which is proof that a sufficient quantity of water has entered into chemical combination with it Rapid introduction of the plaster into the water and careful mixing are also prescribed In regard to the mixing of alabaster gypsum it must also be noted that it requires to be mixed thicker than ordinary gypsum and should not be poured immediately after mixing

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18 JUL 1910

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THE BRITISH ANTARCTIC EXPEDITION

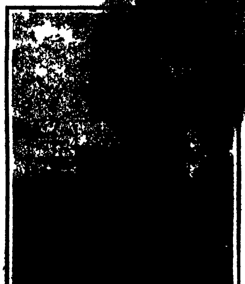
CAPT SCOTT'S EXPEDITION TO THE SOUTH POLE.

THE interesting announcement was made that the British Antarctic Expedition has started for the south a month or six weeks earlier than was previously expected. Much progress has been made with various sections of the expedition The accompanying illustrations and descriptive matter of the ship and of the hut in which the members of the expedition will live while on shore are taken from the Sphere. The 1910 expedition will not winter on the ship as in 1902-4 but will establish a base on shore and the Terra Nova will therefore be able to act as relief ship as was the case in Sir Ernest Shackleton's Expedition

A recent number of The Geographical Journal opened with an interesting account of Capt Scott's plans for his proposed Antarctic Expedition coupled with an indication of the official geographical attitude toward the enterprise So far as the attainment of the South Pole is concerned it is pointed out that only about a hundred miles separate Mr Shackleton's farthest south from that point There is no reason to suppose that that particular spot exhibits any features of exceptional scientific interest and the Royal Geographical Society would hardly approve of an expedition with the South Pole as its sole objective On the other hand it is useless to deny that there is a widespread feeling that this feat should be accomplished by an expedition sailing from this country As citizens says The Geographical Journal we all share in this sentiment, and we may moreover as geographers legitimately take full use of this opportunity of obtaining public assistance for Antarctic exploration As regards Capt Scott's proposal to establish two bases one in McMurdo Sound at the western end of Ross's great ice barrier the other on King Edward VII Land at the eastern end of the barrier the Geographical Journal suggests that it is quite likely that the attempt to reach the South Pole will again be made by the route opened up by Capt Scott and Mr Shackleton from the western end of the barrier It is stated that it will entirely depend on circumstances which of the two bases is used as the headquarters

THE HUT IN WHICH THE 1910 EXPEDITION WILL LIVE AFTER THE SHIP HAS LANDED THEM ON THE ANTARCTIC CONTINENT

[illegible] being erected in the dock district not far from the wharf where the "Terra Nova" lies Her internal arrangements are [illegible] d ermin [illegible] final divisions of [illegible] be set ed when this [illegible] ing place [illegible] on the Antarctic [illegible]

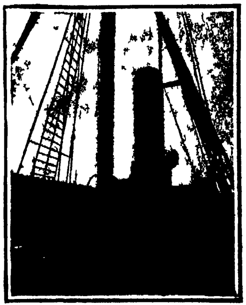


THE STERN OF THE "TERRA NOVA."

Her gilded stern bears the words "Terra Nova," St. John's, N S

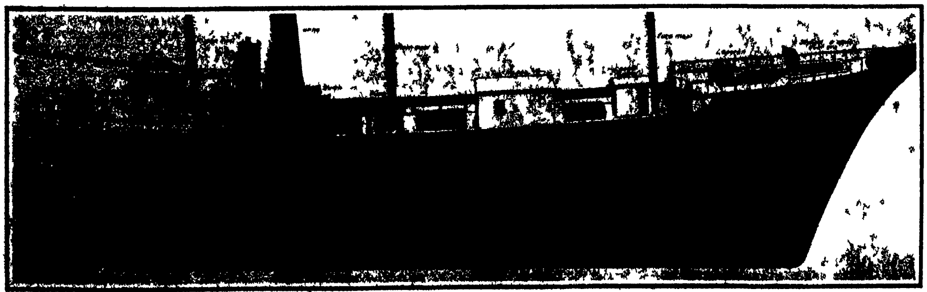
SOME SEASONED ANTARCTIC SEAMEN WHO WILL AGAIN ADVENTURE THE ICY SOUTH

Many of the men who were with Capt Scott in 1902-4 are again accompanying him to the far south—a few lucky ones it is hoped to the farthest south. Some of these men are now actually employed in getting things ship-shape on the Terra Nova, which resounds with the shouts of men lowering spars, the clanking and flapping of hammers, and the general hustle of busy preparation



AFTER QUARTERS OF THE "TERRA NOVA."

The "Terra Nova [illegible] with auxiliary steam power



SECTIONAL VIEW OF THE 1910 ANTARCTIC EXPEDITION SHIP, THE "TERRA NOVA" SHOWING THE DISPOSITION OF STORES, ENGINE ROOM, LABORATORIES AND OFFICERS'S AND MEN'S QUARTERS

THE BRITISH ANTARCTIC EXPEDITION

of the main force of the expedition Should a favorable spot be found in King Edward VII Land the greater force may be landed there, and the lesser force be intrusted with the work of carrying out the important station observations to be made in McMurdo Sound and the collection of further details about the geographical and geological features of the region

The Terra Nova is the largest and the strongest of the old Scottish whalers Built at Dundee in 1884 she is 187 feet in length and 31½ feet in beam that is 15 feet longer but 2½ feet narrower than the Discovery She is considered the best ship ever launched for the Greenland whale trade and has always been a most profitable possession to her owners Of late years consequent on some decline in the whaling business she has been occupied in seal hunting in the northern waters sailing from St John's N F

The Terra Nova however, has not confined herself to the humdrum of trading In 1903 she was purchased by the Admiralty as relief ship for the Discovery Expedition and after being considerably strengthened duly made her appearance in the Ross Sea as The Voyage of the Discovery relates The year 1905 saw her in the service of the North Polar Expedition on a visit to Franz Josef Land Thus she has ranged from the great ice barrier in the south to the north polar pack from extreme to extreme of the navigable waters of the globe The size and strength of the ship make her a fitting receptacle for the extensive equipment which it is necessary she should carry for the full success of the plans of the expedition It is certainly most gratifying to think that the expedition will sail in a ship which is both British built and British owned

The Terra Nova' is a great deal larger than the Nimrod The increased size is necessary for the more extensive plant of the expedition, for it is held that Sir Ernest Shackleton's farthest south can only be surpassed by taking more men and more equipment Further, it is to be remembered that the programme of the expedition includes two bases for the purpose of scientific work and geographical exploration and of course this also necessitates a large vessel The Terra Nova is of the ordinary whaler type She is a sailing ship with auxiliary steam power Most of these ships are comparatively poor sailers, but in making long passages with a fair wind the sails are of course an enormous advantage and in going to the south they are a great aid in saving coal The roominess of the Terra Nova will be much appreciated by both officers and men of the expedition

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SCIENCE AND THE HUMANITIES.*

THE VALUE OF GENERAL CULTURE TO SCIENTIFIC INQUIRY.

BY PROF. ALBERT G. KELLER.

Not so many years ago in his famous book on education Herbert Spencer put forth a powerful plea for the study of science At that time in England at least science stood in need of so adroit and compelling an advocate for classicism was dominant in the educational field and had taken on the arrogant assurance of the unchallenged But Spencer's gauntlet fell with no uncertain sound he made about all there was to make out of a strong position The vigor of his assault is still borne witness to in certain quarters by a scarcely waning exasperation with the essay on education and the author of it

Nowadays however an advocacy of that kind is *not called for* as respects its *brief for science* The book on education is now for the most part of no more than historic value For the very watchword of our age is science It is the fashion to profess scientific method whatever one may be doing Historians caper about in their enthusiasm over scientific method in history and even wish to call history a science Even the philosophers profess to analyze scientific method and the use of the scientific imagination as new phenomena capable of being resolved into their psychical elements and put together again before astonished and troubled eyes Truly science has been victorious all along the line

In the face of this happy vogue of what was once despised and rejected by a former generation I do not propose to say that it is about time for the pendulum to swing the other way This pendulum figure is one of those oracular tell complacent and inexpressibly exasperating metaphors employed by people who imagine that they are saying something when they are actually dinning into our ears with damnable iteration Two and two are four! Two and two are four! But I do wish to remind fellow scientists of the inevitableness of the humanities and of humanity to assert not only that our lives may be enriched by the pursuit of culture in diverse forms not only to express my belief that our destinies must be impoverished by the renunciation of all lines save one but also to insist upon the more concrete contention that our special scientific work is bound to suffer as a consequence of the neglect of that for which the humanities stand

Since the man's work must always be a function of the man it is essential for the best work that the man shall refine his mind in all ways possible to him before he has the assurance to attempt to give of its products to other people Refinement of mind and refinement of character moreover are not so readily disassociated as we have sometimes been given to understand There is something in the nature of truth that does not brook the investigating hand of the common churl The narrow minded meanly read scientist is competent perhaps for the coarser tasks of the truth searcher but his mind and heart are not open to those impalpable influences which play so significant a part in enabling the scientist to correlate his work with human life to throw it into line with cosmic forces rather than to leave it in isolation as a poor side issue soon antedated and passed by It is never possible to predict from just what source that inspiration as we call it will come that suddenly appearing perspective which clarifies the vistas of the obscure and humdrum and affords a new orientation And yet it is the grandest ideal of the scientist to receive at some rare time some pregnant hint which shall transform the laboriously gathered baser metals of his dogged uninspired research into the gold of a comprehensive synthesis Let him therefore perfect his receptivity for his work's sake if for no other, let him become and remain sensitive in the most delicate sense alive to the subtler suggestions which ring in the ear of the cultural monotone but whose quality is outside the limited range of his perception

But—to leave the less tangible and what may seem to some to be the sentimental aspects of the case before us—the need of the humanities is a very actual one to any scientist who essays self expression The training of no scientist can be considered as truly adequate until he is able to convey his idea in something better than the amorphous grunts of the caveman or the conventional formulæ of his peculiar jargon We have been prone to beat with the forehead before the Germans but it is evidence of the passing of irrational fetichism that at last timorous and other murmurs are to be caught floating down the breeze to the effect that after all some fault can be found with the Teutonic style One great and downright scholar has warned some of us that we must always translate a portentous mysterious sounding German sentence into English before one lies down [illegible] track of its oozy involutions and lets it back [illegible] him in order to see whether it really means a[illegible] *after all The German language this man* [illegible] say lends itself easily to pathos

American scientific publication is open I b[illegible] to much less of this sort of criticism nevert[illegible] one says but little for it when he admits this [illegible] a long way from the normal American scientific [illegible] duction up to that of a Huxley—for Huxley's e[illegible] are real literature but are seldom hallmarked as such by being served up in courses on English literature Our scientific writing is full of mannerisms, it is often entirely barren of choice in expression, of lightness of touch and of grace in general It is feebly imitative of uninspired models Sometime in the glacial age the primitive scientist coined all the little stock of pet scientific expressions while the primitive politician was first pointing with pride or viewing with alarm and both scientists and politicians hand on the now somewhat debased currency with cheerful pedantry and naive trust One gets as weary of this *stereotyped and slavish or slothful unoriginality as* he does of the incessant rustic jibe or colloquialism A certain administrator is reported to have struck the swan mark on all his geese by reporting them to be men of fierce mind but people got to saying that whatever the mental qualities of these prodigies the experience of being told about them was fierce enough for anybody

What the scientist needs, in his writing at least is to have some style about him—if he is going to do himself justice that is and appear to those of his colleagues who have taste as an anticipated pleasure rather than as a necessary bore And certainly, if a scientist is to attempt in any degree to popularize science, he must get some sort of personality and finish into his presentations No man, not even a Lincoln, picked his style out of thin air, one gets that sort of thing if we are to believe biographies and autobiographies out of the much association with the great masters of the humanities

I have mentioned the popularization of science to some scientists I am aware, this function seems to be an unworthy one So it may be—and dangerous too, to the populariser's career—if it means writing or lecturing to suit the taste of many a popular magazine or sensation-seeking audience, but it is not unworthy when the essay or the lecture is of the Tyndall stamp Long centuries ago, a conceited but really gifted Roman declared that it was a thing to be ashamed of if one had so submerged himself in study as to be unable to bear forth any fruit of his labors to the common store It is indeed part of the humanities to be willing to share with the knowledge seeking public what portion of one's intellectual acquisition they can apprehend The public is no longer content with the old style clerical harangue—science in its popularization has helped secure that much of advance at the least Referring to this obsolescent style of popular discourse Galton has said The religious instructor in every creed is one who makes it his profession to saturate his pupils with prejudice Those days are over science is now the mode, and it is the business of the scientist to saturate the largest possible portion of the public with a leaning in favor of what he regards as true thinking These are no days and this is no country for scientific ascetics, practising through lone vigils the art of [illegible] the uninformed or the no[illegible] be pure to adopt [illegible] sand is pure [illegible] must come a test [illegible]r humanities [illegible] your acquaintance [illegible] men's minds The [illegible] is assistants and [illegible] of science must [illegible] institution his [illegible] am scarcely competent to speak of the relation between the directors of labor and those directed, but certainly the throes in which sections of our country groan from time to time indicate the need of men of large sympathies and of tact, as well as of trained judgment in places of power throughout the industrial system Speaking however of the teacher, and in particular of his relations to those duties which are imposed upon him by the logic of the tuition fee and of the endowment of instruction it has always seemed to me that it is the essentially narrow minded man who despises or affects to despise these obligations Especially does it seem, if he is young, that his sense of the values *of things must be perverted or atrophied*—that he is a morbid character too little in sympathy with the world of men—if he can allow himself to be drawn off into endless acquiring to the virtual neglect of imparting Human relations keep the mind healthy and the feet upon the earth, and nothing can be more truly contributory to the integrity of one's adherence to truth-seeking than is that essential honesty of mind and character which will not brook the thought of evasion of duty Both the college and the scientific school have numbered great scientists among their most loyal and self-sacrificing administrators and their most patient and conscientious teachers Willard Gibbs, to name one of the greatest of Yale scientists, met, it is true, relatively few students and perhaps no undergraduates, during the last years of his life, but he was the most punctilious of men in assuming his share in the college administration—in that dealing with student woes and that guiding of student destinies, which it has become, in some measure, the fashion to decry as subversive of, or deadening to scholarship That sort of work never operated to deaden the mind of a Whitney, a Penfield or a Sumner There is scarcely any activity connected with research which is so wholesome in its results along the line of self-correction, as is the process of imparting to the less advanced.

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* The Yale Scientific Monthly

Even the case of Darwin supports this contention Owing to his chronic invalidism, Darwin became in many respects a virtual recluse But he maintained a scientific correspondence with all sorts and conditions of men—not seldom replying at length to fervent communications from youths half again more zealous than baked—a literary relationship of which Weismann writes 'The number of people with whom he carried on a scientific correspondence is simply astounding He received many letters says his son, from foolish, unscrupulous people and all of these received replies Darwin entered largely into the simple life of the village where he lived serving as treasurer of a Friendly Club for thirty years and even acting as county magistrate One can easily infer that he could not have viewed his relations to a college, or even backward students with indifference

The reason why the mind devoted to science needs these humanities is because one sided development means deformity Darwin is sometimes cited as a case in point In a famous passage of his autobiography he deplores the fact that poetry art and music have ceased to gain the response from his mind and heart that they had once evoked

My mind, he says seems to have become a kind of machine for grinding general laws out of large collections of facts but why this should have caused the atrophy of that part of the brain alone on which the higher tastes depend I cannot conceive A man with a mind more highly organized or better constituted than mine would not I suppose have thus suffered and if I had to live my life again I would have made a rule to read some poetry and listen to some music at least once every week for perhaps the parts of my brain now atrophied would thus have been kept active through use The loss of these tastes is a loss of happiness and may possibly be injurious to the intellect and more probably to the moral character by enfeebling the emotional part of our nature

Thus, at the end of his life, the greatest scientific figure of modern times albeit with characteristic self depreciation laid down the principle that the greatest scientist must take account of the emotional factor—must be an all around man Darwin at least saw the worth of what he thought he had himself sacrificed and here it may be recalled Spencer fell short of Darwin, precisely along those lines where Darwin thought he himself had fallen short of self realization The relationship between science and the humanities is not one of opposition but a complementary relationship rather of mutual reinforcement One of the things most sure to awaken distrust of the scholar or author is the conviction often an intuitive one, that he does not see life whole This is why the specialist has so often cut but a sorry figure in the estimation of his fellow men why the scientist has been regarded as a cold blooded freak and the humanist as a gushing impractical dilettante The humanities have often needed an injection of that brand of science which Huxley describes as organized common sense and science has needed humanization and will always need it so long as the human mind is not intellect alone

This admixture of the humanities must come early Most of us who are not specialists in the humanities have done the bulk of our readings in literature and have made our ventures into art and music during college days or shortly thereafter Once involved in the sweep of competition or in the routine of a specialty time and energy have not been left over for extensive forays outside the chosen field This is one of the reasons why one should deplore premature specialization I firmly believe that no one should allow himself to get past his doctor's degree or what may correspond to that stage without immersing himself for a time in a discipline which if he is to be a scientist is calculated to appeal to those of his faculties which seem unlikely to enter largely and directly into his career They will so enter for as I have tried to intimate the most wholesome mental product is secured by a species of cross fertilization between the mental faculties The love of a scientist for the humanities—of all kinds may at the humblest attain for him a relaxation and relieve the tension that is always approaching the breaking point or it may determine in large measure the mood in which he approaches his labors or it may contribute to secure that perspective which results in a non distorted apprehension of values and if it can do nothing else it is sure to aid one in imparting what he finds out The symmetry of the work is a function of the symmetry of the mind behind it

It is at this season of the year that one restlessly looks forward to the completion of another lap in the race for an education and wonders what will be the most satisfactory way of spending the few months of swiftly approaching vacation Some few indeed are so fortunate as to have most alluring opportunities of trips abroad or some other definite plans which assure them of both a happy and profitably spent vacation On the other hand are arrayed that large bulk of the undergraduates whose plans are still uncrystallized and whose desires even have as yet found nothing definite to focus upon To this large majority we address ourselves

Most Yale men know in a hazy way that there is a place called Northfield where the Y M C A contingent of the college is apt to assemble after the close of the spring term Few believe that it is a fit place for the live and energetic who have not the weight of wicked man upon their shoulders To the initiated however Northfield means far more than a place of solemnity for the extremely religious Those who have been fortunate enough to enjoy the pleasures of comradeship and healthy contact with men of their own kind those who have lived for a week or ten days in that indescribable atmosphere of clean thought and vigorous outdoor life found at Northfield know that at no other place can the short beginning period of their vacation be spent more profitably or more enjoyably

It is a great gathering of college men in which are found representatives from nearly every large school and college in eastern United States and Canada Yale is usually the best represented institution at the conference Yearly one hundred and thirty or forty Yale men attend Regretably Sheff men in general have not in previous years availed themselves of the opportunity of going to Northfield

The life at the conference is varied Prominent speakers may be heard daily and the ideas expressed by them bear the attention of all serious minded men Combined with this spiritual side of the life is the great diversity of outdoor amusement There are good tennis courts The swimming is excellent Base ball games are played every afternoon A track meet and a grand celebration and bonfire are events which make the life anything but monotonous

To those men who have not yet planned anything for the period between June [illegible]th and July [illegible]rd we can recommend no more desirable a place to visit than Northfield It is a distinctively American institution worthy of your recognition

EUGENICS AND MENDELISM.

IMPROVING THE HUMAN RACE.

Anyone who [illegible] at all knows full well says the [illegible] overcrowded countries [illegible] all parts of the world the condition [illegible] is susceptible of great improvement from every point of view This statement indeed puts the case mildly for in the largest cities the state in which the very poor live is a direct and constant menace to the nation and to the white race generally Too many individuals are born nowadays who are handicapped from the outset by physical and mental disabilities due to poverty heredity that is if heredity plays an important part in the physical and mental make up to environment and to an upbringing which render them unfit to wage successfully the battle of life Such persons are a detriment to the nation to which they belong and the most disquieting feature of the situation is that they increase at a far more rapid rate than the better class of citizens This brings about the tendency not merely to further degeneration in itself sufficiently alarming, but what is even more alarming a deterioration of the general average Thus certain countries of Europe are faced with these disturbing facts that not only is the population of their towns degenerating but the race as a whole, is deteriorating in body and mind The nations whose inhabitants are chiefly in towns are in the worst position, but even in America affairs in this respect do not give cause for unmixed satisfaction In a few words, it may be stated as an undoubted fact that in all parts of the civilized world the least desirable part of the population from a physical and mental standpoint is producing more numerous progeny and it would seem that unless means can be devised to stay this flood of the unfit, in the course of time the entire race must descend to a lower level as regards physical and mental qualities Men of light and learning everywhere recognize the gravity of the position, and various measures have been suggested, some of which have been in part adopted, to keep the race at a high standard

Of late the aid of eugenics and more recently still that of Mendelism has been invoked in this direction, and by some enthusiasts it is declared that in the practice of these theories the solution of the problem lies. In this country, during recent years, a great [illegible] has been heard of stirpiculture and the physical examination of those wishing to be married has been strongly urged So far as the doctrines of Mendel and his disciples are concerned less interest appears to have been taken in these in America However in Europe and perhaps particularly in Great Britain the followers of Mendel have been strenuously insistent that in the adoption of these teachings rests the salvation or rather the physical and mental regeneration of the race A few far seeing persons have attempted to stem this tide of enthusiasm and to indicate the exact state of the case Among these is Dr Squire Sprigge the editor of the Lancet who in the Contemporary Review for November 1909 subjects the matter to close scrutiny and throws the clear searchlight of common sense upon the points at issue In the first instance he very appositely draws attention to the fact that the problems of heredity are not yet solved so as to be able to lay down any hard and fast dicta to inherited predisposition to disease At a debate on heredity from the standpoint of disease held by the British Royal Society of Medicine in 1908 it was shown that certain obscure and rare nervous diseases were hereditary and that organic epilepsy might be inherited With regard to cancer some of the most prominent authorities deny that this disease can be proved to be hereditary while several of the recent workers on tuberculosis believe that the condition is in no wise inherited and a well known British authority confessed himself as skeptical of even a predisposition to tuberculosis being inherited Of course the obvious degenerates drunkards imbeciles and those profoundly tainted with blood poisoning should be debarred, if possible from propagating their kind but outside this class who in the present position of knowledge regarding the laws of heredity, is to say which couple is fit to mate and which is unfit?

The followers of Mendel assert that in the teachings of the remarkable Abbot of Brunn is to be found the solution of the fundamental riddles of heredity and if this be so there is reason to believe that the question of suitable marriages may be successfully attacked by them It must be borne in mind though that neither the truths laid bare by Mendel himself nor the advance on these truths made by his disciples has up to the present solved the problem Mendel discovered marvelous facts by his experiments in flower culture notably in pea fertilization and his followers have greatly improved on his experiments in fowl and rabbit breeding But the result of experiments thus far do not authorize the statement that human breeding can be influenced in a similar way although they may point to a possibility in that direction Indeed even in flower culture it is not known except by individual experiment what qualities will respond to the Mendelian notation and whether such will be dominant or recessive in action The possibility of avoiding the transmission in certain plants of certain qualities has been demonstrated by avoiding certain alliances and if any practical rules as to the transmission of disease can be given to medical men by the Mendelists a great step in advance will have been made in regard to the position of Mendelism in eugenics Now according to Sir William Gowers with respect to disease the Mendelian theory appears to be borne out in the transmission only of pseudohypertrophic paralysis The Mendelian theory has infinite possibilities in regard to the betterment physically and mentally of the human race but as yet these are but possibilities On the whole Sprigge is far from being convinced of the value of the medical certificate before marriage as one of the chief planks of the eugenic platform until the Mendelians have supplied the medical profession with more accurate knowledge of the workings of heredity upon which to base their decisions

It is the desire and object of medical and scientific men to improve the breed of human beings but on the other hand it is not the intention of these men to lead the ignorant astray as to the chances of so doing A little learning is a dangerous thing and it is those who know little who are generally most certain concerning partially known scientific truths This is the case with respect to eugenics and Mendelism The learned biologist may hope and imagine that the most sanguine expectations of the Mendelists may be realized, but the dabbler in science is positive they will be and talks as if they were already realized

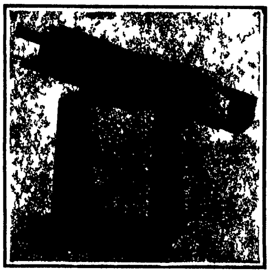
THE QUALITY OF LIGHT.*

ARTIFICIAL LIGHT VERSUS DAYLIGHT.

BY PAUL F. BAUDER.

WHAT is the relative value of the light given by artificial illuminants as an artificial duplicate of daylight? Such a broad use of the term daylight has led to much discussion between the advocates of each artificial light source It is the purpose of the author to submit results of some investigations upon which an estimate can be formed as to the comparative merits of each of the more common commercial illuminants

At best daylight is a great variable but nevertheless it has generally been the light to which artificial sources have been referred It is apparent that this light must have certain fundamental characteristics which make it a standard A standard of illumination must however have certain requirements the most important of which is constancy There are so many varying conditions which affect the light from the sun that no definite standardization of average daylight has been universally agreed upon by investigators Those qualities for a standard unit of illumination which mark the sun as the ideal illuminant for the majority of conditions may be classified under the following headings



IVES COLORIMETER.

Intensity
Color value
Direction of rays
Ability to reveal detail
Adaptability

These five qualities will be discussed separately

INTENSITY OF DAYLIGHT ILLUMINATION

Referring to the first of the five qualities we will consider the intensity of daylight illumination

The sun is brightest at noon i e the sun is at its maximum intensity when there is the smallest chance for its direct days to enter the eye and injure the retina The eye of man is naturally protected by the projection of the forehead from the high intensity of the suns light during the larger portion of the day At sunrise and sunset however the rays of light of maximum intensity come in a horizontal direction and are therefore more liable to injure the delicate interior of the eye The usual presence of mist or fog and the greater absorption due to an additional depth of atmosphere at the horizon decrease the brilliancy and give to the light a diffusion and color tone, which cause no injurious effect upon the eye Although the principle of a light source varying to meet natural conditions cannot be applied to artificial illuminants that of placing the light source above the range of vision so that the natural construction of the eye may be utilized is immediately appreciated

The diffusion and reflection obtained in artificially-lighted rooms are far different from the effects obtained with sunlight or daylight The height of interiors limits man in employing to the best advantage the principle of diffusion in planning artificial illumination

Actual sunlight which has been referred to is a quantity unknown upon the earth The source of sunlight is distant from the surface it illuminates by more than eleven thousand times the diameter of this surface During the greater portion of the day about fifteen or twenty per cent of the total light received from the sun is diffused daylight scattered from finely divided particles suspended in the intervening space between sun and earth If this atmospheric condition were not present the sky would be dark and spaces to which the light rays were not directly admitted would likewise be dark

The eye will adapt itself to great changes in [illegible] intensity of daylight A similar relative percent[illegible] change in brightness of artificial light sources as [illegible] used would however be prohibitive On accoun[illegible] the fact that the variation in intensity has bu[illegible] slight effect upon the ease with which the ave[illegible] person can work under natural light there mus[illegible] some characteristic of daylight which under cer[illegible] conditions will produce a much more marked [illegible] upon the human eye than that previously mentioned This fact is shown in many industries where the light used must be uniform in color value if not in intensity

Light is radiant energy which in the form of waves of different lengths affects the nerves composing the retina of the eye These waves express themselves as different colors Average daylight or so-called sunlight is a clearer and whiter light than that from any artificial lighting source thus far perfected. When allowed to fall upon a prism however it is immediately seen that this white light is composed of seven visible and easily distinguished colors namely red orange yellow green, blue, indigo and violet in varying proportions These colors are the seven fundamental or visible spectral colors which form a part of [illegible] the sun This wave radiation [illegible] man sight only [illegible] en the red and [illegible] let extremes of [illegible] of these values [illegible] on of the radi [illegible] to their wave [illegible] readily be shown [illegible] ould be one in which [illegible] proportioned as to color would occur between the limits of red and blue and therefore would be visible

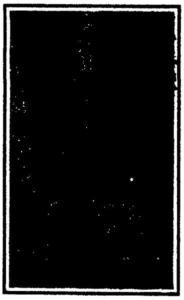


CHART FOR ILLUSTRATING VISUAL ACUITY

By holding red green or blue glass between eyes and chart variation in sharpness of detail is shown

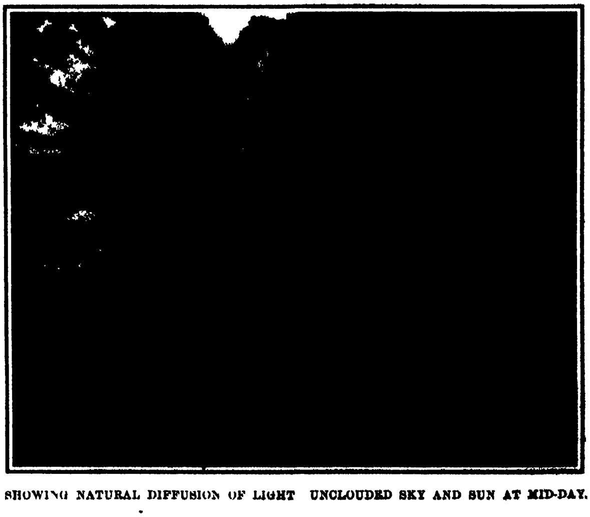
Daylight is composed of varying proportions of the seven visible colors The greatest variation in the quality of daylight may be attributed to the varying percentages of these fundamental colors A certain relationship in all kinds of daylight exists between the different colors which when combined form it A proportion remaining practically the same under most conditions is that the amount of blue light in nature is maximum while the red is minimum Such a proportion of the fundamental colors can be likewise noted in all growths in which the reds are produced to a less degree while the blues and violets are always apparent Other primary colors composing daylight vary in amount between the two limits A similar statement is true for all forms of light radiation whether natural or artificial, in the latter, however there does not exist the same proportion of fundamental colors as in any form of daylight.

The following table gives the Nichols results for per cent of color in daylight It expresses in percentages the results of measurements of daylight by Prof Edward L Nichols, as given in the Transactions of the Illuminating Engineering Society for May, 1908:

GENERAL AVERAGES

Average,	Wave Lengths in Centimeters.					
	Red	Orange	Yellow	Green	Blue	Violet,
	[illegible] × 10^{-4}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] × 10^{-4}
For— Lower levels,	5 28	[illegible]	13 71	[illegible]	[illegible]	[illegible]
Higher levels,	4 14	[illegible]	12.87	[illegible]	[illegible]	[illegible]
All stations	[illegible]	[illegible] 71	[illegible]	[illegible]	[illegible]	[illegible]

By exhaustive observation it has been found that any color of light can be duplicated by combining in various quantities three of the primary or spectral



SHOWING NATURAL DIFFUSION OF LIGHT UNCLOUDED SKY AND SUN AT MID-DAY.

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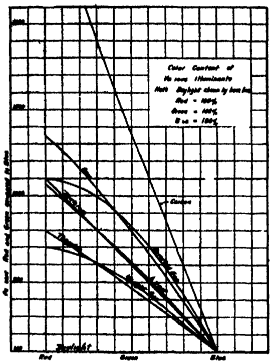
* Paper read before the Franklin Institute

colors, namely, red, green, and blue In laboratory practice as well as commercially by the process of trichromatic photography, it is shown that color shades and tones can be correctly reproduced by the proper combination of these three instead of the seven colors This principle has been embodied in an instrument invented by Mr F E Ives and called the Ives colorimeter It is an instrument which gives correct percentages of the three primary colors composing the light from any of the present incandescent light sources In this apparatus the three primary colors of light are combined by a so called color mixing device and allowed t[illegible]half of the field in the instrument the [illegible]ted by the source under tes[illegible]

By regulating the pr[illegible]ors Dr H E Ives of the B[illegible]plicated the color of aver[illegible]ise made accurate determi[illegible] the proportions of the thr[illegible]ght from many artificial [illegible]iven in a paper presented b[illegible]eering Society Several [illegible]likewise made measurem[illegible]value of blue light composi[illegible]much in excess of that sh[illegible]

As previously sta[illegible] three colors of light comp[illegible]e that a standard for aver[illegible]ult to obtain How varia[illegible] may be more readily appreciated if one comp[illegible] colors as seen in the light of a north window with the same colors as seen at a west window in the light of the late afternoon sun Not only do the natural conditions of the atmosphere produce such great changes in the color value of light but it must be recognized also that certain conditions affect this quality as much or more than atmospheric changes The causes of variation in the color of daylight entering any space may be tabulated as follows



PER CENT OF RED GREEN AND BLUE IN VARIOUS ARTIFICIAL ILLUMINANTS AND IN DAYLIGHT

Daylight taken as standard and shown by base line

Causes involving the sky alone	1 Clear blue sky 2 Cloudy sky 3 Overcast sky 4 Natural conditions due to rain or snow 5 Natural conditions due to dust or snow 6 Artificial conditions due to smoke or chemical vapors
Causes involving the surroundings	1 Condition and color of surface of ground 2 Trees shrubbery or gardens in proximity 3 Walls of adjacent buildings 4 Character of windows or openings for the admission of light

The color quality of light which enters any given space may vary in any of the three fundamental colors composing it as much as twenty to thirty per cent according to changeable conditions of atmosphere and surroundings For this reason it can readily be understood that a standard of daylight has not yet been obtained with which artificial illuminants may satisfactorily be compared

The variations which have been mentioned allow of enough changes to take place to make daylight of different qualities unserviceable for some classes of interior work There are relatively few art studios and shops where articles of a delicate color value are sold in which it is possible to make a proper comparison of color on all occasions This is due to the many varying conditions affecting the quality of daylight which enters

It is apparent that more consideration should be given to this characteristic of daylight when it is compared with artificial illumination Not only should this condition be taken into account in art galleries and other locations where the color of decorations plays an important part in making the sales but it should also be considered in home interiors offices and other places where the color plays an important part in the harmonious appearance of surroundings For instance a man living in a city is much interested in the color which a neighbor paints his house as it greatly affects the light received through his side windows Decorative effects are greatly varied by the condition of the color of the surrounding buildings etc to such an extent that when the sun's light is reflected from a light colored surface such as a snow covered ground or a white wall of a building a flat indistinct appearance is given to interior effects With an exterior ground surface of a soft color tone from which the light is reflected to an interior the quality of light reflected produces a color effect which greatly improves the interior appearance

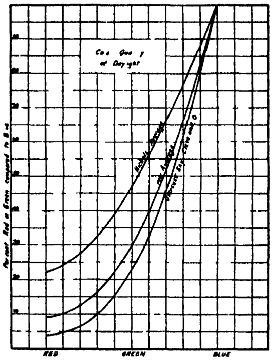
DIRECTION OF RAYS OF LIGHT

The directional relation of natural light plays a very important part in the general appearance of any surroundings Maximum daylight is usually received in a plane approaching more nearly the vertical than the horizontal causing shadows and high lights to appear in correct proportion On the other hand an extremely flat effect would be caused by a light with almost complete diffusion caused in nature both by the presence of suspended dust particles clouds and many reflections from surrounding objects A very similar effect is produced when the difference between the lights and shades is too highly accentuated as in the case of objects illuminated by a search light

It is seen from this that there is a necessity for directing light into such locations that there will be sufficient direct as well as diffused light to make a harmonious shading from high light to shadows without a marked change from one to the other Shadows may be considered by some as unimportant because it appears that a person can see almost as well in diffused sunlight caused by clouds as in direct sunlight

On days when there is no direct sunlight there is considerable shadow but there is a less sharp contrast between light and shade because of the gradual character of the change Were it not that shadows are always present the work of the architect would not appear very artistic particularly in exterior work In interiors the numerous windows acting as light sources cause complex shadow effects making the problem of illumination with the proper proportion of light and shade more difficult The adoption however of the principle of taking exterior conditions into account would no doubt have a marked effect Shadow depends upon direction of light If the lower or less illuminated portion of an object as seen in daylight were thrown into the light and the upper or more illuminated portion in the dark the object would be almost unrecognizable Reverse the condition and it at once stands out in detail With perfect diffusion however we have none of this light and shadow effect which makes an object plainly visible

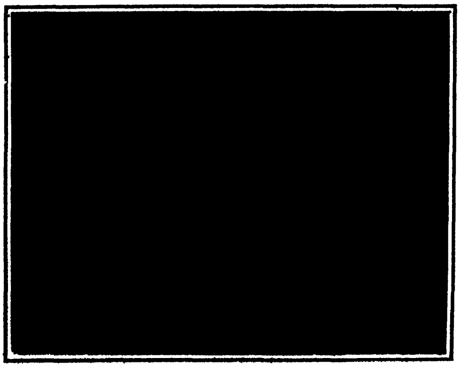
This question of having the proper direction of light in order to make objects visible invisible or of revealing detail has a direct bearing on the question of visual acuity The color value of light in making possible fine distinctions of detail plays a more or less important part in the physiological effect produced upon the eye It is found in daylight that a person doing work which requires a proper consideration for fine lines and detail will not depend upon the direct light from the sun but will in all cases seek a diffused illumination This may be obtained in a shadow or from a portion of the sky which is not the brightest In reading, a person will always prefer the light obtained from a window, which is not receiving direct



CURVES SHOWING PER CENT OF RED AND GREEN LIGHT IN DAYLIGHT

Blue taken as 100 per cent in all cases

CORRECT APPEARANCE OF OBJECTS AS ILLUSTRATED BY SHADOWS



INCORRECT APPEARANCE OF OBJECTS WITH ALL SHADOWS REVERSED. (NEGATIVE OF JUXTAPOSED ILLUSTRATION) rays of the sunlight unless a shade or curtain of some kind obstructs the direct rays and softens them in intensity and color value. It is true that different eyes are affected differently. Some require more light of one quality than others, but in the majority of cases it must be noted that light for proper purposes of reading or fine distinction will be within certain limits and must likewise be of a certain quality and diffusion to allow the least possible direct light to enter the eyes of the observer.

In dealing with the subject of visual acuity or power of revealing detail with lights of different color value the effect of large light variation must be considered. Most commercial sources of light due to slight causes vary so greatly in their individual characteristic color quality that it is found necessary in order properly to designate the best light for given purposes to turn to the primary colors and note which is best.

Most people find themselves shortsighted for the light from the blue and violet ends of the spectrum. For the power of revealing fine detail with an accompanying ease of sight the blue and green lights are to be preferred to the red for short distances. By looking through red, green and blue glass at the chart this point can be easily observed. The red on the other hand is preferred by the majority of persons for revealing details at a greater distance. Keeping this principle in mind it can readily be seen what an unsatisfactory effect would be produced if a red or blue violet light were to be used for general illumination purposes. The important requirement for a light is then to be able to distinguish color values, fine detail, etc., with the proper intensity and direction whether it be daylight or artificial light. The qualities of efficiency and steadiness of light production apply more directly to artificial sources of light than to that of daylight. These qualities may be grouped beneath the heading of adaptability inasmuch as all light should be readily adaptable to meet various requirements.

ADAPTABILITY OF LIGHT

The light from the sun was primarily used for purposes of mechanical labor where the necessity of revealing fine detail, obtaining proper color quality and intensity were not required to such a great degree as they are at the present time.

On account of the requirements which have been developed in the progress of civilization daylight has failed to answer for all purposes due to the fact that our vocations must be pursued at all times without depending upon daylight. For this reason the adaptability of all sources of light including both natural and artificial must be given proper consideration.

On account of requirements it has been necessary to use prismatic glass and to adopt an entirely new construction of building and skylights in order to use natural daylight for such classes of effort as are generally undertaken for manufacturing and industrial purposes. It is true that artificial illuminants must be adapted for more diverse purposes than daylight. They must likewise be directed in such a manner as to meet all interior requirements. Practically all commercial illuminants have been designed with this thought in mind. The ideal light source on the other hand must have such qualities of color and ability to reveal detail, such intensity and direction of maximum rays as to make it capable in all conditions of service to meet certain requirements depending on the conditions surrounding the work for which they were intended.

ARTIFICIAL ILLUMINANTS

Having discussed the various characteristics of daylight in comparison to artificial light relative to the previously mentioned qualities we will make a few direct comparisons. The characteristic qualities of daylight will be compared with the similar qualities of the following illuminants in an endeavor to determine from the standpoint of adaptability which is the best for given conditions:

1. Carbon treated filament lamp.
2. Carbon untreated filament lamp.
3. Gem metallized filament lamp.
4. Tantalum filament lamp.
5. Tungsten filament lamp.
6. Nernst lamp.
7. Inclosed arc.
8. Upright gas arc.
9. Inverted gas arc.

The light flux of all these lamps is vastly different. *The brilliancy of any of them is so far below that of the sun* that the impossibility of obtaining comparisons in intensity between them and the sun is readily apparent.

In referring to the intensity of the light sources investigated the advisability of placing a light source of high intrinsic brilliancy a sufficient height above the floor level of any space in order to benefit by the principles previously noted regarding the sun is self-evident. An alternative likewise possible is to reduce the intrinsic brilliancy of the source by using glassware of proper design and intensity to increase the diffusion of light and to decrease its brilliancy. By the use of this principle the necessity of resorting entirely to height in order to produce a sufficient diffusion of light is eliminated.

The question of the color value of given commercial light sources is one which has caused more diverse opinions to be raised than any other quality of artificial illuminants. All artificial light sources have a characteristic quality of color which is apparent from observation. The colors of the investigated illuminants may be listed as follows:

	Designation	Color
1	Carbon new	Yellow
2	Carbon seasoned	Orange yellow
3	Carbon metallized new	Pale yellow
4	Carbon metallized seasoned	Yellow
	Tantalum new	Yellow white
6	Tantalum seasoned	Lemon yellow
7	Tungsten new	Cream white
8	Tungsten seasoned	Yellow white
9	Nernst Lamp new glower	Pale lemon yellow
10	Nernst Lamp seasoned glower	Deep lemon yellow
11	Inclosed arc opal outer clear inner globe	Bluish white
12	Gas arc upright new mantle	Pale greenish white
1	Gas arc upright seasoned mantle	Pale greenish yellow

The colors of these sources are not readily apparent when used for general illumination purposes. Nevertheless when a given series of colors is viewed beneath the light from any one of them the effects produced vary a great deal from the true color values as seen under daylight illumination.

The true importance of obtaining the best form of illuminant in order to give the most desirable and attractive results for all classes of service may be observed when a comparison is made between the color effects produced by the illumination from artificial light sources in comparison with that of daylight. A surprising advance has been made in the incandescent lamp industry in the endeavor to obtain a type of lighting unit which would cause objects to appear more nearly natural under artificial illumination.

Not only for store lighting but likewise for residence lighting the production of the proper color values and of the proper intensity and direction of light to give a pleasant appearance to interiors should be the general aim for all users of artificial light.

Not only from the standpoint of the merchant but likewise from that of the architect, the interior decorator and furnisher, there is the necessity for obtaining the best means to advance his efforts in artistic lines. *This view should not be limited to mere financial ends* for the use of light but a lasting benefit should be gained by improving the standards for all classes of human effort in art and decoration as well as commercialism.

It has been shown that from the standpoint of direction of light there must be for satisfactory illumination not a complete diffusion but a balance giving the proper proportion of light and shade.

Esthetic tastes are sometimes appealed to by an incorrect use of illumination in order to impress the observer with the beauty of surroundings. A more useful result would however be obtained by making the most practical efforts to impress the user of artificial light with the necessity for living and working to his best advantage under conditions requiring the use of artificial light. Owing to the inability of natural light to meet our modern requirements for constancy of intensity, color value, etc., it is obvious that artificial light sources correctly applied must be adopted.

It has [illegible] that some of the investigated sources are [illegible] one condition of service than are others. It [illegible] concluded that the best artificial [illegible] commercial market at present [illegible] to the largest number of [illegible] that it maintains a high standard [illegible] qualities of light.

The [illegible] best possible illumination can [illegible] when it is considered that at [illegible] before there is in the mi[illegible] broader comprehension of what [illegible] tion.

The five [illegible] lighting source should not be [illegible] ands of dollars are spent annually [illegible] of pleasing lighting effects. If these [illegible] and the art of illumination placed [illegible] higher plane we are greatly benefiting humanity.

OXIDATION IN SOIL-FERTILITY

The rôle of oxidation in soil fertility is discussed by Oswald Schreiner and Howard S. Reed in a bulletin which has recently been issued by the Bureau of Soils of the Department of Agriculture. The results of the investigation show that roots of growing plants exhibit intercellular oxidizing power which may be demonstrated by the use of suitable chromogens in nutrient solutions or soil extracts. The oxidizing power appears to be most energetic in the region of the root where root hairs are found and to decrease gradually in activity as that portion of the root becomes older. The oxidizing power of plants grown in extracts of productive soils is greater than that of plants grown in extracts of unproductive soils. Treating the soil extracts with an absorbing agent is usually beneficial to oxidation. The distillate of a poor soil extract which contains volatile toxic compounds was less favorable to oxidation than the residue remaining from distillation. The process of oxidation is usually accelerated by the addition of nitrates to an aqueous soil extract. The addition of ammonium sulphate is less beneficial to oxidation than the addition of an equal amount of nitrogen in the form of nitrate. Calcium salts were found to increase the amount of oxidation in cultures to which they were added. The addition of potassium salts was not generally beneficial to the process of oxidation. In some cases their presence caused a material retardation of the oxidation. The most of the retardation was due to the action of the potassium itself and not to the formation of acid conditions in the solution. Sodium or ammonium salts of the same acid were more favorable to oxidation than the corresponding potassium salt. Phosphates usually produced material increases in the oxidation in solutions to which they were added. Chlorides and sulphates, when combined with a suitable base like sodium are somewhat beneficial to oxidation but are not as favorable as the corresponding nitrate would be.

The presence of toxic organic substances in solution was extremely deleterious to the oxidizing power of the plants. The oxidizing power of the plants especially in the presence of nitrates was able to alleviate the toxicity of such solutions.

The process of oxidation by roots is largely if not entirely due to the activity of a peroxidase produced by the roots. This oxidizing enzyme is most active in neutral or slightly alkaline solutions. The activity of the enzyme may be inhibited by the presence of acid and also by the conditions in solutions where putrefaction processes occur. This oxidation by roots has considerable agricultural interest since processes promoting oxidation play a large part in the best methods of soil cultivation and tillage.

CO-OPERATION TO PREVENT FOREST FIRES.

Secretary of Agriculture Wilson has signed an agreement with the Great Northern and Northern Pacific roads, says The Railway and Engineering Review, which provides for co-operation of the forest service and railroads to prevent damage to national forests from fires. The companies agree to clear and keep clear of inflammable material a strip of varying width as conditions may demand up to 200 feet beyond the right of way and to provide all locomotives which do not burn oil with suitable spark arrestors and other standard equipment to prevent the dropping of fire. In fighting fires railroads and the forest service will co-operate closely. Prompt notification to forest officers of all fires discovered by employees of the railroads is provided for. Telephone lines to make this possible will be put up by the forest service using company poles where this is desirable. Warning whistles will be sounded by locomotives on occasion. Forces of fire fighters will be assembled on the outbreak of fires made up of forest officers, railroad employees and such temporary labor as can be gathered by either. Except for salaries of regular employees the cost of fighting fires which start within 200 feet of railroads will be borne by the railroads and the others by the forest service. The agreement provides that the forest service will regularly patrol the rights of way during a fire season.

In the course of an interesting paper on "The Progress of Electric Braking on the Glasgow Corporation Tramway Service," read by Mr. A. Gerrard before the members of the Institute of Electrical Engineers, the author said the Glasgow Corporation Tramways Department was at present engaged in fitting to each car an automatic sanding apparatus, the component parts of which were a solenoid and a continuous flow sand valve. The coil of the solenoid was inserted in the main breaking circuit, and its armature was connected to the continuous flow sand valve, so that when the solenoid operated the sand valve was opened, and a copious supply of sand was projected on the rail without any effort from the motorman. A spiral spring was attached to the valve in such a way as to work against the action of the solenoid, and adjusted so that if the electric brake was applied for an ordinary service stop or for coasting, the solenoid was prevented from opening the valve and serving out the sand when it is not required, but in the event of the motorman making an emergency stop, the current flowing through the circuit was sufficient to operate the solenoid and automatically to supply sand at a most opportune moment.

THE LATE SIR WILLIAM HUGGINS.

A PIONEER ASTROPHYSICIST.

The death of Sir William Huggins which took place in London on May 12th, closes a long life of useful activity devoted to pure science, a life full of recognition and honors If official recognition of his merits came late in his life—as it often does in this country, as well as in others—official honor was finally meted out in full measure while his fellow scientists had from the first paid tribute to the distinguished work in astronomy and solar physics accomplished by an earnest worker who was not a professor not connected with any of the great national institutions nor even a graduate of any English university all his degrees being honorary He was in his seventy fourth year when the Order of the Bath together with the knighthood was conferred upon him on the occasion of the Queen s Diamond Jubilee, in 1902 the late King made him one of the twelve original members of the Order of Merit The Royal Society elected him a fellow in 1865 two years after the presentation of his first paper honorary degrees medals and other distinctions followed and in 1900 Sir William Huggins succeeded Lord Lister as President of the Royal Society As such he presided over the inauguration of the National Physical Laboratory by the present King and Queen while the numerous foreign distinctions awarded to him testify to the general esteem in which he was held all over the world

William Huggins was born in London on February 7th 1824 and was thus in his eighty seventh year when he died after an illness of only one day He was educated at the City of London School and at home Private tutors instructed him in classics mathematics and science, and it must not be thought that the Royal Society somewhat deviated from its custom by offering the presidency to one of their members who had confined his studies to one branch of science Young Huggins in fact, was long in doubt whether he should take up physiology and microscopical research or pursue his life study chiefly with the aid of the telescope His decision in favor of the [illegible]cope came at an opportune period It was o[illegible] years after he had been able to erect a te[illegible] at Tulse Hill in 1856 that Kirchh[illegible] [illegible] at Heidelberg in 1859, the [illegible] put spectrum analysis on t[illegible] most important means of [illegible] physicists like Kirchhoff and [illegible] the sun, others went furthe[illegible] whether the starry world [illegible] the same constituents or so[illegible] [illegible] known or believed made [illegible] this work Huggins collabo[illegible] Allen Miller professor of [illegible] [illegible]ege A star spectroscope [illegible] [illegible]se it had to be created T[illegible] [illegible] exceedingly weak and the identific[illegible] [illegible] the spectrum with the instruments the[illegible] was most difficult Progress was in fact in the first years of stellar spectroscopy, as Sir William Huggins himself later remarked much retarded by resting important conclusions upon the apparent coincidence of single lines in spectroscopes of very small resolving power

By 1863 Huggins and Miller presented their first joint paper to the Royal Society a Preliminary Note on the Lines of Some Fixed Stars The very day it is said that they read this paper they were informed that Rutherford in the United States and Secchi, in Italy were engaged in similar work The question of priority was hotly contested not by the chief workers, but by their friends Huggins never was the man to speak of his own achievements His modesty could not but strike even the most casual acquaintance But his friends felt all the more called upon to urge his claims The whole controversy was futile It would indeed have been astonishing if stellar spectroscopy had been initiated without some such coincidence and in fact one cannot now help wondering a little that the discovery of spectrum analysis should have lain dormant so long a time In stating this we do not in the least desire to deprive Kirchhoff and Bunsen of the credit which is so justly accorded to them for their remarkable systematic investigation A few words will explain our reasoning Fraunhofer himself wrote in 1817 that to judge by the (Fraunhofer's) lines, the light of Venus and of Mars was that of the sun, while the light of Sirius differed, in other stars, moreover, he observed different bands in 1831 J F Herschel stated in 1835 that the series of 'fixed lines" in the spectrum of stars like Sirius was totally different from that of any known terrestrial flame The elder Herschel had observed in 1823 that the yellow sodium flame was characterised by a yellow line, and it was apparently the ubiquity of this line which prevented him and others from following the problem up " Still more noteworthy is Wheatstone's report of 1835 to the British Association in which he describes the lines seen in an electric spark when striking into mercury there were the two D lines one green one blue one indigo one violet line and sparks from other metals he noticed gave other lines

Continuing their studies Huggins and Miller examined in their laboratory the puzzling differences between the spectra obtained under different conditions One of his later successful researches carried out in conjunction with Lady Huggins who after his marriage in 187 had become his able and enthusiastic assistant and joint author of his memoirs should be mentioned in this connection It had been noticed that the general sun spectrum displayed seventy two calcium lines while in the spectra of the chromosphere and of the prominences only two lines could be attributed to calcium That discrepancy was so strong that the whole identity of the solar calcium lines was questioned everybody is aware what an importance is attached to calcium vapors in the solar atmosphere In 1897 Huggins established that at sufficiently reduced pressure the number of calcium lines was indeed diminished to two This difficulty having been cleared up, spectrophotography in calcium light could take its established position

Stellar spectrophotography had been attempted by Huggins in the early sixties But the imperfection and unsuitability of the old silver plates and of the wet collodion plates which were then alone available baffled his endeavors When he resumed this branch in the seventies the gelatine bromide plate almost perfect apart from its grainy texture as he remarked in his presidential address to the British Association at Cardiff in 1891—had been invented and thanks to the interest that the Royal Society took in his work, he was in possession of a 15 inch refractor and an 18 inch reflector fitted with mirrors of speculum metal besides a spectroscope provided with quartz lenses and prisms of Iceland spar which did not stop the ultra violet rays Thus he was able to study the spectra of stars with a view to their classification as proposed by Secchi in 1863 and modified by H C Vogel in 1874 The order in which Huggins arranged the stars from their photographic spectra in 18[illegible] was essentially that of Vogel to quote Huggins s own words Soon afterward he was able to show that the star like nuclei in the Orion nebula really belonged to the nebula and were not in front or behind the nebula

He had been studying nebula since 1864 and had been able to decide whether nebulæ were to be regarded as portions of the fiery mist or shining fluid out of which in the elder Herschel s words the heavens and the earth had slowly been fashioned or whether they were external galaxies cosmical sand heaps too remote to be resolved into separate stars The spectrum of the nebula in Draco proved to be the bright line spectrum of a glowing gas upon a background of a faint continuous spectrum Turning his attention to the spectrum of comets Huggins found carbon vapors in it thus confirming a suggestion thrown out by Donati in 1858 Laboratory experiments on olefiant gas and other hydro carbons confirmed Huggins in his opinion that hydro carbons were to be found in the constituents of comets When delivering the Bakerian lecture in 1885 Huggins regarded the corona of the sun as similar in the cause of its formation to the tails of comets—that is consisting for the most part of matter going from the sun under the influence of some force probably electrical Many of the corona particles might return to the sun but those forming the long streamers did not return and diffusing they might he suggested go to furnish the matter also of the zodiacal light The cometary matter he considered identical with that of meteorites

One of the signal triumphs of the work of Huggins was his application of the Doppler principle to the study of the motion of stars in the line of sight. In his original paper on Das farbige Licht der Sterne published in 1841 at Prague Doppler had suggested that the difference in color observed in some binary stars might be produced by their motion Doppler was right in so far as the principle is as true in the case of light as it is in the case of sound but he was wrong in supposing that a change in color could actually be recognized even if the star were moving with such an enormous velocity as to alter sensibly its color to the eye Huggins understood that the principle became applicable as soon as lines of known substances had been recognized in stellar spectra and his first observations of 1868 were soon confirmed by Vogel and Scheiner at Potsdam by Christie at Greenwich and later by Keeler at the Allegheny and the Lick observatories. The latter was also so fortunate as to measure with the magnificent instruments at his disposal the motion of planetary nebula in the line of sight How greatly this important method of research has since been developed by able observers on both sides of the Atlantic is now well known

Huggins also was a pioneer in solar physics The suggestion that it would be possible to observe solar prominences any day—not only during solar eclipses—with the aid of the spectroscope was due to him The idea was that the spectrum of the prominence would be sufficiently bright while the prisms would disperse the air glow Huggins also suggested—and Zoellner at the same time that if a wide slit were slowly removed from the limb of the sun the prominence would record its own width at different distances from the limb and thus its shape The first actual observations of this kind were secured by Janssen in 1868

When the phenomena of radioactivity were investigated early in this century Huggins took up the spectroscopic side of the problem We cannot however further specify his work on the present occasion That he continued to excel is best proved by a long series of distinctions conferred upon him The Order of Merit which we have already mentioned he valued highest The Royal Society which admitted him in 1865 awarded him a Royal Medal in 1866 the Rumford Medal in 1880 and the Copley Medal the highest honor at its disposal in 1898 The Royal Astronomical Society whose president he was in 1876 had given to him and to Miller a gold medal in 1867 Honorary degrees had come from Cambridge in 18[illegible] when he was Rede Lecturer and from Oxford soon afterward The Paris Academy awarded him the Lalande Prize for astronomy in 187[illegible] and the Prix Janssen of the Institut fell to him in 1888 He also held the Wilde and the Draper Medal and the Medal of the Pacific Astronomical Society During his presidency of the Royal Society in 1900 to 1905 he accentuated the value of the study of science against the advocates of humanistic studies and selection from his presidential addresses to the Royal Society were published in 1906 under the title The Royal Society or Science in the State and in the School His most important works are the Publications of Sir William Huggins s Observatory of which the first volume entitled An Atlas of Representative Stellar Spectra appeared in 18[illegible] while the second volume The Scientific Papers of Sir William Huggins K C B O M was published only last year

In 187 Sir William Huggins had married Miss Margaret Lindsay daughter of Mr John Murray of Dublin herself a great astronomer and joint author with him also of the atlas just mentioned A man of a happy humorous disposition very fond of children whom he delighted to interest by simple demonstrations Huggins became more retiring and reserved in his older days He had the true modesty of the true scientist ready to advise and to help fellow workers and he was a man of high culture Sufficiently endowed with means to live in comfortable circumstances he possessed quite a noteworthy collection of early Italian art treasures and built himself a pneumatically driven organ The instruments which the Royal Society had intrusted to him were in 1908 offered by him to the Cambridge Observatory and were at once accepted He spent all his life practically at Tulse Hill The end came as suddenly and from the same causes as that of King Edward within less than a week of the King s death The funeral took place on Saturday last the 14th inst his remains being cremated at Golders Green Lady Huggins survives him he leaves no children —Engineering

BRENNAN MONORAIL SYSTEM FOR ALASKA.

It appears that the first practical application of Louis Brennan s gyroscope monorail car is to be made in Alaska where a system of monorailroads will be built connecting several camps Exclusive rights to use this car in Alaska have been granted to an American syndicate represented by J E Ballaine of Seattle, Wash and a firm of New York bankers The syndicate has agreed to build one hundred miles of railway within one year following the completion of two cars an order for the construction of which has been given to Louis Brennan in London Mr Ballaine is quoted in reports as follows I estimate the cost of the 100 miles of line we are going to build from the Matanuska coal fields toward Fairbanks will not exceed $3 000 a mile compared with at least $20 000 for even the lightest double-rail track "

ATMOSPHERIC ELECTRICITY.*

A REVIEW OF OUR PRESENT KNOWLEDGE.

BY ELIHU THOMSON.

The study of the nature and origin of electrical storms or disturbances throughout the atmosphere is of much interest our knowledge is yet meager there is much more yet to be learned in this fascinating field Exploration of the electrification of the air at varying heights by captive balloons by kites and upon elevations of land has generally shown an increasing electric potential upward from the earth and usually positive in relation thereto Sometimes this relation is reversed It has been roughly estimated that if the differences noted can be assumed to be extended to include the total depth of the atmospheric layer the earth s surface might be negative to the surrounding space 150 000 volts more or less This condition would not admit of being regarded as constant or stable since widespread electric storms occur in both our upper and lower air levels In the highest regions of our atmosphere they take the form of diffuse discharges as in a high vacuum and are called auroras They either accompany or give rise to magnetic storms which affect the direction and intensity of the earth s magnetism temporarily and hence disturb the compass needle sometimes through many degrees

The frequency of auroral phenomena and perhaps also to some extent the frequency of thunder storms seems to keep pace with the sunspot period at least in our latitudes At times of sunspot activity the surface layers of the sun upon the energy radiated from which so much of earthly activity depends are stirred by great storms or immense cyclones of hot gas or metallic vapors storms seen as dusky spots on the sun s disk They can attain enormous size—[illegible]0 000 30 000 or even [illegible]0 000 miles in diameter though these dimensions are exceptional They are visible as is well known not because they are nonluminous but because they are less luminous than the surrounding solar surface In like manner bright spots or faculæ may also be seen because they are on the whole brighter than the sun s surface adjoining them

There is much reason to believe that in accordance with suggestions made many years ago these solar storms are accompanied by exceptionally vigorous projection outward from the sun to immense distances of streams of electrified matter Should the earth happen to be in a position to be swept by such a stream an aurora may be produced During a total solar eclipse the so-called coronal streamers are seen to extend from the sun s surface to distances of upward of two millions of miles or possibly farther than that but doubtless they keep on outwardly and invisibly to relatively enormous distances It is not unreasonable as a hypothesis to imagine that they may extend at times as far as the orbit of the earth and may if the direction is the proper one reach our outer air

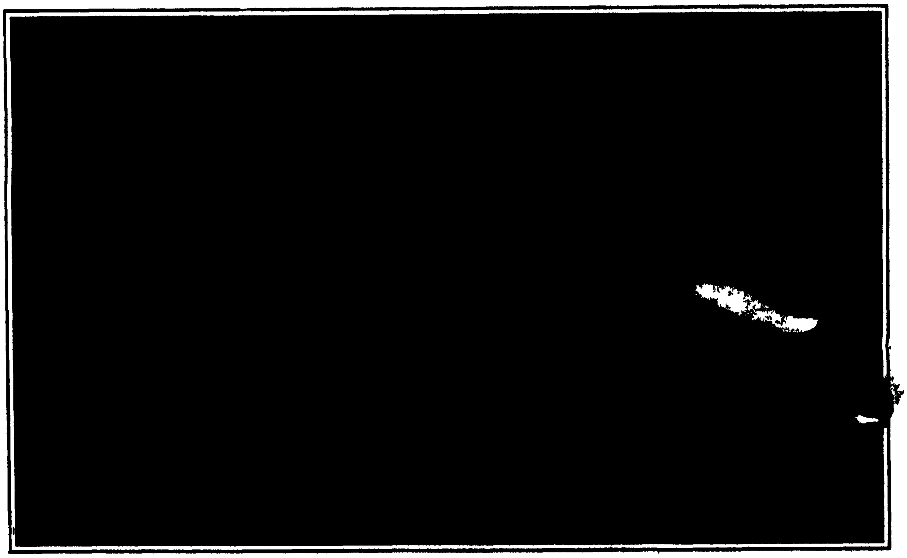
Further if they consist of electric ions or particles conveying electric charges an aurora may result Dr Hale of Mount Wilson Observatory has indeed recently shown by the spectroscope that great solar storms are in fact attended by the motion of electric ions at enormous velocities The phenomena of auroras present peculiar difficulties in their study since as in the case of the rainbow no two observers at a distance from each other see the same or identical appearances Hence attempts to determine the height by triangulation at which auroras exist give most contradictory results for it is impossible to fix upon any condensation or streamer which may not be displaced or absent to another observer some distance away This is understood when we bear in mind that the luminous appearances are not located in one plane but are distributed in space condensations of light being the result of superposition in the line of observation

I have come to the opinion that the auroral streamers often extend in a general direction outwardly from the earth sometimes to very great distances relatively to the known extent of our atmosphere The effects observed appear unaccountable upon any other supposition while they are consistent with the idea of outwardly directed streams of great extent In April 1883 there occurred an aurora which was at its maximum a little after midnight It was the most magnificent display of the kind which, in spite of a continual vigilance on my part it has been my fortune to witness. It was upon such a scale that so to speak the mechanism of the streamers stood revealed At that time I could not avoid the conclusion that the auroral streamers must have extended outwardly several thousand miles There is no space here to present the argument involved Perhaps the most significant fact is that precisely the same general appearances were noted in Chicago as in the East and that they occurred simultaneously The interesting question arises Does the earth temporarily acquire streamers similar in nature to the solar coronal streamers? The answer is as yet unknown At the time of the great display mentioned there was a sunspot near the center of the sun s disk of about 50 000 miles in diameter During that disturbance long telegraphic lines could not be operated owing to the arcing at the keys which prevented interruption of the circuits Apparently in subtle sympathy with its master orb the sun, the earth s electric and magnetic equilibrium was for a time profoundly disturbed

While it is by no means certain that auroras and magnetic storms are always dependent on solar outbursts it is now generally recognized that the observed coincidences are too frequent to be the result of chance It is perhaps safe to assume that although solar storms and sunspots can occur without provoking auroras or magnetic storms here it may be doubted if these latter occur on any great scale unless solar activity is coincident therewith And it seemingly is true that only when the projected electrified matter actually reaches the earth or comes near enough to inductively affect its electrical equilibrium are the terrestrial phenomena produced thereby

It has even been suspected that a greater frequency and severity of thunder storms in our lower air accompanies the active period of the sun on sunspot maximum This is a hypothesis which would require a careful collection and comparison of data over a long period to give it status as a scientific fact or wholly to disprove it Be that as it may experience with lightning damage in electric installations seemingly supports the idea and led me in a paper given some seven or eight years ago during the minimum period to predict a severe ordeal a few years in advance As a matter of fact the prediction was to a large extent verified with the result of extraordinary activity in devising safeguards from which the electrical engineering art now benefits In general the harm done by thunder storms is due directly or indirectly to the heavy spark discharges called lightning flashes or strokes of lightning.

It may be of interest to refer briefly to the conditions existing in a cloud which is the source of such destructive energy. As is well known, [illegible]



STUDY OF AN AURORAL CURTAIN MADE ON JULY 5 1902 (1 H A M TO 2 H A M) DURING THE NATIONAL ANTARCTIC EXPEDITION (1901)

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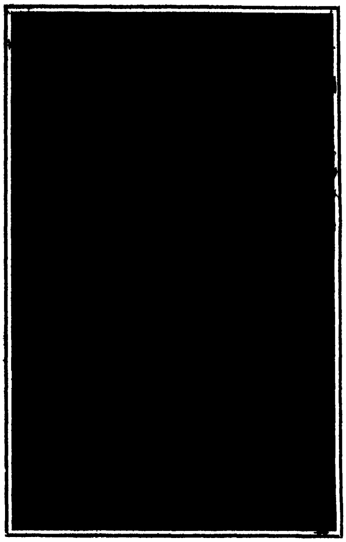
* [illegible] Laboratory [illegible]

of fine water particles suspended in the air. When frozen these particles are crystalline like minute snow crystals. All clouds above the snow line are likely to be of that character. At a temperature above freezing the particles of water are microscopic spheroids which may by gradual coalescence form drops of rain. This process of coalescence necessar[illegible] total surface of the water existin[illegible] Should however, the original [illegible] slight electric charge, the[illegible] ening the total surface, or [illegible] pacity results in a gr[illegible] pressure on the su[illegible] coalescence con[illegible] cloud as rai[illegible] diminution of [illegible] tric pressure c[illegible] sufficient to account [illegible] thunder storms in winter [illegible] causes contribute


ANTARCTIC AURORAL STREAMERS

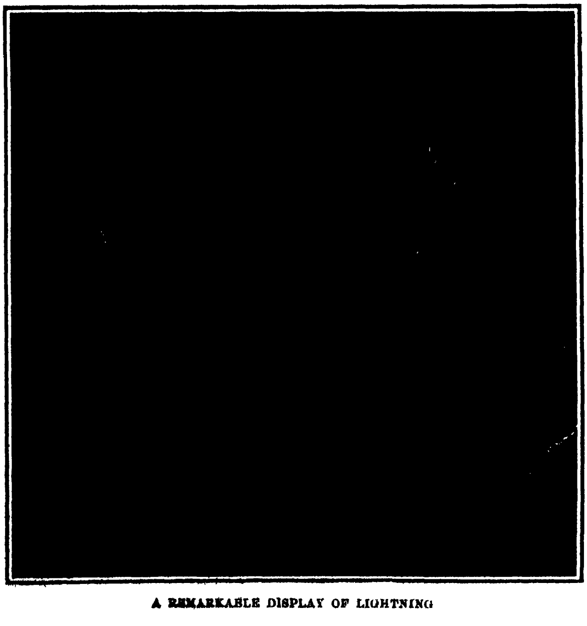
A thunder cloud ha[illegible]compared to an insulated charged conductor such as a body of metal hung upon a silk cord but in reality the two are not at all comparable It is a mistake to assume any close analogy to exist The cloud being only an air body containing suspended water particles is not a conductor nor can it as in the case of metal permit the accumulation of its electric charge on its outer surface In fact it possesses no true definite outer surface but blends with the clear air around it The electric charge it possesses remains disseminated so to speak throughout, and must reside chiefly upon the surface of its constituent water drops Accumulation in any part would require the insulating air between the drops to be overcome

A lightning stroke from such a mass may indeed represent a discharge of hundreds of amperes at millions of volts We must, however be cautious not to exaggerate either the current or the potential present in a lightning flash The current in a flash can at times be only a few amperes or may in the heavier discharge reach perhaps hundreds, or possibly in extreme cases some few thousands of amperes It is doubtful if the potential much exceeds at any time more than a few million volts as it is probable that small local breakdowns start the disruptive process which then extends through miles of length The individual water particles even when collected into drops cannot be charged to such enormous potentials as millions of volts In reality it is the combined effect of the numerous particles acting inductively that accounts for such pressures A combined stress is set up toward the earth or toward another cloud mass of opposite charge. The lightning stroke results from a breakdown of the insulating air layer between them, and slips all through the cloud itself, and for a time a partial neutralization or electric equilibrium is effected. This continues until a further redistribution of charges is [illegible] and until again the breakdown potential is reached The continued coalescence of charged water particles which were not discharged at the first breakdown repeats the original condition, and so on Unlike the case of a suspended charged metal body a single discharge does not usually equalize the electric potential of cloud and earth Instead many successive discharges occur It is probably fortunate for us that the process is as gradual as it is for the ordinary partial discharges of the cloud are each terrific enough and tax our resources sufficiently when we seek to protect ourselves and our effects from them

Various hypotheses have been proposed to account for the presence of electric charges in cloud masses, but there is no time to discuss them here and there is in fact little that is really known as to the origin of the electricity of clouds We shall briefly refer to the phenomena which characterize or accompany the electric discharges The usual form which the discharge takes is that known as disruptive spark or fork lightning a long flash or electric spark joining earth and cloud or cloud and cloud and branching within the cloud mass like a tree Oftentimes between cloud and earth there is seen the single streak zigzag in its course but within the cloud it ramifies or branches extensively in several directions In this way only can any considerable part of the cloud contribute its portion to the main discharge path for as stated before the cloud cannot act as a conducting body

Some authorities treat lightning as a discharge of very high frequency like the ordinary discharge of a condenser or Leyden jar In fact it has not been unusual to assume that such apparatus can be substituted and inferences drawn as to the nature and character of the lightning discharge from experimentation and tests with these laboratory appliances There is however abundant reason to doubt that lightning discharges are really oscillatory If they oscillate the conditions are such as to forbid such oscillation being of a high frequency order The cloud discharge represents what is known as a discharge of a large capacity and the length of the path or spark may reach thousands of feet or even many miles a long inductive path while the heat and light given out in every part of the path indicate a high resistance to the passage of the discharge All of these conditions are together known to be inconsistent with the idea of high frequency oscillation But the breakdown or discharge is extremely sudden and involves an almost instant rise of the current to a large value so that the inductive effects upon surrounding structures such as electric lines or circuits are very energetic and sharp like a quick blow struck and these lines or structures become the seat of rapid vibration or high frequency oscillations The sudden blow of the hammer on a bell in like manner brings out all the rates of the vibration fundamental and overtones of which the bell is capable and in which the hammer itself takes no part

The very sudden startling character of a lightning discharge leads to an exaggeration in the popular estimate of its more evident effects The amount of light given out is not so great as is often assumed It does not give effects at all comparable with full sunshine While doubtless the intrinsic brilliancy is very high the duration of the flash is small generally only a minute fraction of a second In photographs of lighting the landscape is generally seen only in outline or poorly lighted by the discharge In the daytime when the clouds are not dense enough to greatly darken the sky the flash loses most of the blinding character it


A REMARKABLE DISPLAY OF LIGHTNING

has when seen in the blackness of night Similarly the sound of thunder though of terrifying quality is not extraordinarily loud It is a common experience when traveling in a train to note that the sound of even near by flashes is smothered by the roar of the train so that no thunder is heard The noise of thunder cannot be due in any part as is sometimes erroneously assumed to collapse of the air upon itself and into a partial vacuum left by the spark I have seen this error even recently repeated and even extended to include all the noise of thunder as due to such collapse When however we consider that in a minute fraction of a second the air in the path of the discharge is so highly heated that if it were confined its pressure due to heat expansion alone would rise to more than ten atmospheres we can readily understand the explosive shock given to the surrounding air and the propagation therethrough of an intense air wave In fact such waves from electric spark discharges and from dynamite explosions have been clearly recorded by photography Moreover that the collapse of the air after expansion can have little or no effect in the sound production follows from the fact that the heated gas streak left in the path of the discharge takes an appreciable time to cool on account of its low radiating power This is shown by the observation that a lightning discharge in dusty air is often succeeded by a luminosity of the streak which persists for a perceptible time and slowly fades away like the luminous trail of a meteor

Another common misconception is that the prolonged rolling character of thunder is due to reverberations or echoes In mountain regions with steep rock walls such reverberations possibly contribute to the effect but it is now clearly recognized that a sufficient single explanation suffices for most cases Owing to the great length of the lightning spark or path we receive the sound from the near parts of the discharge far in advance of that from the more remote portions and between these sounds are those from parts of the path at intermediate distances from the observer It follows from this that no two observers at a distance from each other hear the same succession of sounds in the thunder of a discharge Whenever portions of the discharge path are situated or extended in an approximate direction at right angles to the line from the observer the sound from that part of the path is louder or of high amplitude owing to the sound from that part of the path reaching the observer's ear at the same instant Whenever the path leads directly away from the observer the amplitude is less the sound is less explosive and takes the character of an extended roll or rumble

It will be seen from this that every twist and turn and every change of direction of the spark path with respect to the observer's position gives a varying loudness and sequence of sounds Every branch of the main discharge in like manner records its position and direction its twistings and bendings in these sound vibrations and sequences It would seem possible even to record on a phonograph noises from sparks invisible to the eye and map the positions of the sparks in space from records so produced If this were done as it were stereoscopically or stereographically from two or more separated observing or recording places the records would contain the necessary data for the reconstruction of the spark and its branches in space

From the above considerations an attempt to determine the distance of a lightning stroke to earth by counting seconds elapsing between the flash and the first thunder and allowing five seconds to a mile approximately is seen to be futile Should one of the cloud ramifications or branches of the great tree-like discharge extend in the cloud overhead with relation to the observer and that part of the discharge be nearer to him than any other he will first hear a receding rumble above him followed it may be by a heavy explosion from the main or approximately vertical spark between cloud and earth and from the parts at which his distance is nearly the same This louder explosion will then be followed generally by a prolonged rumble of diminishing loudness which is the sound coming from the ramifications which lead farther to the distant parts of the cloud Manifestly the counting of time should be between the flash and the heavy explosive sound due to the vertical part of the flash

Bearing in mind that over the extent of cloud the charged water particles may be said to be waiting for a chance to discharge to earth it is not surprising that any path which has been opened or broken down by disruption of the insulating layer of air should serve for the discharge of an extended body of cloud The heated vapor or gas in the path of the discharge is a relatively good conductor of electricity serving to connect the cloud mass to the earth below The significance of this is understood when it is known that many lightning discharges are multiple Instead of a single discharge they consist of a number rapidly following one another through the path or spark streak opened to them by the first discharge This first discharge opens the way or overcomes the insulating barrier to the discharge of portions of the cloud mass which, on account of remoteness or lower potential could not themselves have caused the breakdown These repeated or multiple flashes are exceedingly dangerous both to life and property The first discharge may reduce wood to splinters and the subsequent ones set it on fire The time interval between the successive discharges in such a multiple flash is quite variable and may be long enough to be easily perceptible by the eye The multiple character is easily disclosed by the image in a revolving mirror If a strong wind be blowing at the time of such a multiple flash the hot gas conducting the discharges may be displaced laterally in the direction of the wind with the result of spreading out the discharges into a ribbon more or less broad Photographs of these ribbon flashes show their true character plainly each separate discharge appearing as a streak of light parallel to the others and at varying distances apart In part parallel discharges of exactly the same contour are sometimes observed many feet apart Here the hot gas of the first discharge has evidently been shifted by the wind over a considerable space before the second and subsequent discharges took place Heavy rain seems to weaken the air and help to precipitate a discharge From the fact that strokes of lightning are often followed by increased fall of rain within a few seconds it is a prevalent idea that the increased downpour is caused by the discharge In reality the reverse is the case for just when a gush of rain has reached from the cloud down to within a hundred feet or more from the ground by far the major part of the air layer has been so weakened electrically by the presence of the water drops that the discharge itself anticipates the completion of the distance of fall of the rain and is therefore a short time in advance of the time when the descending gush of rain actually reaches the ground As the gust or gushes of rain are more or less local and sweep along with the storm cloud they are apt to mark out the places of the most frequent lightning strokes Shelter sought at such times under tall trees is particularly dangerous

The amount of energy which may be concerned in a lightning discharge is neither definite nor capable of estimation It would seem that the widest variations in energy may occur and this would account largely for the observed differences in the severity of the effects It must be remembered also that by far the larger part is expended in the long spark in the air and cloud Even when much damage is done to objects struck it is only a small fraction of the total energy which is expended on them Most of the damage to property comes indirectly from the electric discharge by its energy being instantaneously converted into heat This heat evolves steam and expanded gases in the interior of such materials as food and causes explosion shown in the splintering or rupture

A curious effect often noted when a tree is struck and shattered is that when the splinters sometimes of large size are thrown bodily out to distances of many feet from the shattered tree the splinters in their movement remain in parallel to the tree and in a vertical position They are frequently found standing upright after a stroke and at distances ranging up to sixty or eighty feet away This fact indicates that the projecting force is quite instantaneous and is exerted equally and at the same moment throughout the length of the splinter in a direction transverse to its length Such splinters are sometimes ten or twelve feet in length and several inches thick As will be seen a person near a large tree which is so disrupted is in danger of being struck in a different way even if he escapes being included in the path of the stroke itself Aside from this mechanical danger it is known that to take refuge under a tall tree during a heavy thunder storm is particularly hazardous This is so because the human body is a better conductor than the tree trunk particularly as the trunk itself is the last part to become thoroughly wetted by the rain The leaves and upper parts are wet and more or less conducting while the tree trunk itself may be yet dry In such a case the body of a person forms a good path or shunt to the dry trunk and is therefore particularly apt to be traversed by any stroke which reaches the tree

As before indicated damage to buildings and other such structures can in all cases be prevented by the provision of an effective shunting path to earth A most essential feature of such a structure as the Franklin conductor is its good connection with the ground or better its connection with what we know as a good ground In early times it was considered that it was quite important that the tip or upper end of the conducting rod should be sharply pointed or should bristle with sharp points so to speak The tips were gilded and the points made of gold or platinum to prevent rusting The points were supposed to draw off the lightning silently from the cloud and so prevent strokes of lightning But for millions of volts at cloud distances almost all irregular objects on the surface of the earth are practically pointed Perhaps on this erroneous assumption of the action of points as applied here little stress was laid on the direct path to earth being chosen and on the necessity of including with it or connecting to it other good paths such as gas pipes bell wires and the like There is no need of any special provision of points A blunt end will do as well for after all there is practically no silent drawing off of the charge from the cloud for it is not an insulated conductor The provision of a lightning conductor on a building undoubtedly increases its chances of being struck by lightning but if properly arranged it also insures that the structure shall suffer no harm therefrom Viewed from our present standpoint it is a curious historical fact that in 1777 just after the war of the American Revolution broke out a miniature verbal war between the advocates of *blunts* and *points* respectively, as applied to lightning conductors raged In England party politics led many to condemn *points* as revolutionary and stick to *blunts* The Royal Society by majority vote decided for points but those who so voted were considered friends of the rebels in America George III took the side of *blunts* Franklin who from the first had prescribed points wrote from France The King's changing his pointed conductors for blunt ones is a matter of small importance to me For it is only since he thought himself safe from the thunders of Heaven that he dared to use his own thunder in destroying his own subjects The king is reputed to have tried to get Sir John Pringle then President of the Royal Society to work for blunts but received the reply Sire I cannot reverse the laws and operations of nature As stated above it matters not at all which we may use I have indeed seen a number of cases in which the sharp points of lightning conductors had been melted into rounded ends by lightning

In the foregoing we have been considering the effects of such ordinary discharges of electricity as the disruptive spark or zigzag flash Apparently if the testimony is reliable there are other and more rare forms of discharge I allude to sheet lightning so called globular lightning and to bead lightning But it may be asked why call sheet lightning a rare form? It is indeed true that when a storm is so far distant that the spark discharges cannot be seen as when it is below the horizon or when the spark is blanketed by a mass of mist or cloud there is to be noted a diffused light or extended illumination which on [illegible] may not appear to be attended by [illegible] [illegible]ilar effects are often called [illegible] observations during a few [illegible] am led to infer the exist[illegible] [illegible]iseless discharge between [illegible]ended by a diffused [illegible] lightning In [illegible] unusually heavy do[illegible]here where the rain [illegible]tly momentarily lighted up [illegible]ingly close at hand in the space [illegible] The appearance has been seen in [illegible] an intense bluish or purplish momentary [illegible] without any accompanying sound It could scarcely have been illusory It is hoped that other observers will carefully note any such like effect if it occurs It is certainly a rare phenomenon

It is quite common that any very bright flash the details of which from its suddenness and intensity are unobservable be alluded to as a ball of fire Doubtless many of the reported cases of so called ball or globular lighting may be explained as instances of this condition of things Nevertheless there are so many recorded instances apparently in substantial agreement that it is difficult to escape the conclusion that there in reality exists this rare form of electric effect globular lightning

We cannot properly discredit observations of phenomena which are so rare that our own chance for confirmation of them may never come We must in such cases carefully scrutinize the testimony, examine the credibility of witnesses and their chances of being mistaken It is certainly impossible at present to frame any adequate hypothesis to account for this curious and obscure electric appearance The witnesses agree that it is an accompaniment of thunderstorms and that it resembles a ball of fire floating in the air or moving along a surface such as the ground It is not described as very bright or dazzling, and the size of the ball itself may be from an inch or two to a foot or more in diameter Observers agree that it can persist for some time and that its slow movement allows it to be readily kept under observation while it lasts When it disappears there is usually an explosion and a single explosive report like that of gun fire Sometimes it is said to disappear silently Usually the damage done by its explosion is only slight. This summary of characteristics is common to all accounts. Some accounts are even more detailed, mentioning that the fiery ball seemed to be agitated or with its surface in active motion. I have found [illegible] instances occurring many years apart and in widely different localities in which it is described as having a reddish nucleus, in diameter some considerable fraction of the whole The outer fiery mass has been described as yellowish in color In some instances it has been seen to fall out of a cloud It is described as entering buildings and moving about therein Personally I was for a long period in doubt as to the reality of this strange appearance deeming it the result of some illusion or a fanciful myth But on hearing descriptions by eye witnesses known to me as persons not given to romancing and finding their accounts to correspond closely with the best detailed descriptions in publications my doubts have disappeared

In one instance while observing the lightning during a heavy thunderstorm a companion whose eyes were turned in a direction nearly opposite to my own suddenly called to me that a ball had just dropped out of the cloud some distance away The view of the ground was obstructed by buildings and I unfortunately just missed it The noise of its explosion was however heard in the direction indicated by my fellow observer as a single report like the firing of a gun At the time I closely questioned him as to details of the appearance Our ignorance of its possible nature is complete No rational hypothesis exists to explain it Science has in the past unraveled many obscure phenomena The difficulty here is that it is too accidental and rare for consistent study and we have not as yet any laboratory phenomena which resemble it closely

Some times photographs taken during thunderstorms have been found to carry curiously contorted streaks in some degree resembling lightning flashes Generally they have been found on plates upon which undoubted lightning discharges have been recorded In some instances which have come to my notice the streaks have had the appearance of a string of dots or beads and have been taken to represent a very rare form of lightning known as bead lightning A number of such photographs have been submitted to me for opinion as to the nature of the curious streaks In all cases they are explained as due to the camera having been moved without capping the lens permitting images of lights such as arc lights or spots of reflected light from wet or polished surfaces to traverse the plate in an irregular course They are then only records of the inadvertence of the lightning photographer In one instance the effect was so curious that it was several years before the true explanation was found In that case there were two wavy contorted streaks of perfectly parallel and of similar outline but unequal in intensity rising each from a rail of a single track railway and apparently terminating in the air fifteen or twenty feet above the tracks They were finally traced to a moving camera and a reflection from the wet and polished rail surfaces of the light of an arc lamp located outside the field of view It required a visit to the place itself to enable this conclusion to be reached The particular beaded streaks or lines of dots were traced to the fact that the arc lamps causing them were operated by alternating currents which naturally give light interrupted at the zero of current one hundred and twenty times per second being the usual rate All this emphasizes the need of care and wholesome scrutiny or even skepticism before reaching a conclusion in such cases

Is bead lightning which has at times been described as observed visually a reality? If it is it appears to be even rarer than the globular variety Perhaps it is a string of globules a variety of globular lightning But we cannot make assumptions As in the case of globular lightning there is some testimony which cannot be wholly disregarded tending to show that a form of discharge resembling a string of beads can actually exist An account of an instance was given me within one hour after the occurrence its [illegible] The witness was known to me as perfectly reliable The appearance was described as a festoon of finely colored oval beads hung as it were from one part of cloud to another and as persisting for some seconds while gradually fading away The opposite ends of each bead were said to be different in color It was seen during an afternoon thunderstorm and spoken of as very beautiful and altogether different from the usual zigzag flash

If I have dwelt upon these exceptional appearances at some length it is because they seem to show that in electricity there is much yet to learn and abundant opportunity for future investigation It is certainly literally true that in the language of Shakespeare There are more things in Heaven and earth Horatio than are dreamt of in your philosophy Such work belongs to the science of physics now recognized as fundamental in all study of nature's processes In electrical engineering which is in reality an art based upon applied physics the subject of lightning protection has always been one of considerable if not vital importance Just as a lightning discharge from a cloud clear up a path for other discharges to follow so in electric undertakings it opens up paths for the escape of the electricity we are sending out to do the work intended such as for lighting power or other uses In the past disablement of machinery in electric stations has not been rare The recent growth of long distance transmission involving hundreds of miles of wire carried on poles across country over hill and through valleys has set new problems of protection and called for renewed activity in providing means for guarding the lines and apparatus immune to the baneful effects of electric storms Judging the future by the past we may conclude that whatever difficulties of the kind arise in the great future extensions of such engineering work science and invention will provide resources ample for the needs and the rapid advance will be continued

THE EXCAVATIONS OF ARLESIA.

One of the most interesting problems of ar[illegible]logy has been finally solved by the recent ex[illegible]accomplished at Alise-Sainte-Reine lay[illegible]to of Arlesia that city of ancient [illegible] getorix headed 80 000 of [illegible] gallant though futile att[illegible] the victorious legio[illegible]

In 190[illegible] the [illegible]ence of S[illegible] riches of th[illegible] 1909 the p[illegible] closed at Al[illegible]of Alaise (Doubs[illegible]

Caesar's only [illegible] the location of the plac[illegible] words *Alesia oppidum des Ma*[illegible] document exists which confirms tho[illegible] is a votive inscription in the Celtic tongue [illegible]nd in 18[illegible]9 on the plain of Alise reading thus Martialis Dannotali ievru Wacueti sosin celicnon etic gobedbi dugeontiio Wantin in Alilsia This translated reads Martialis son of Dannotalos, made for Weuetis this monument and erects it for Weuetis in Alise Dr Vercontre shows by the text of the grammarian Consentius that in the Gaelic language the letter i is pronounced not as in Latin but with a sound intermediate between i and e It follows that they pronounced as Alesia the written word Alilsia which Caesar merely spelled as pronounced

Napoleon III who wrote a history of Caesar attempted to settle the question by excavating the remains of the admirable lines of contrevallation and circumvallation of more than 16 kilometers in extent drawn by the Roman legions around Alesia but succeeded only in uncovering numerous tombs recognized to belong to a period many centuries prior to that of Caesar

More recently the idea was conceived of digging a shaft perpendicular to the assumed lines of investment The soil of the plateau consists of a soft dark vegetable mold overlying a subsoil hard white compact and flinty In the latter distinct traces were discovered of 1.5 meters to 2.5 meters in diameter, whose outlines were clearly shown in geometrical fashion on the walls of the shaft These lines concurred in design and dimensions with those described in the Commentaries Within these trenches were found bucklers and objects of equipment of Roman and of Gallic origin and bearing in their form and structure the character of arms of Caesar's epoch. In one was found a handsome case of silver, ornamented with a garland of leaves and berries in relief

It seems certain that Alesia was destroyed at least three times. Attentive study of the remains shows three different epochs in the history of a Gallo-Latin city beside the original Gallic period

The first is characterized by walls whose facings are very regular and composed of the best material The construction is very solid and careful and the joints have usually been fired

The second epoch (at the end of the first century A D) shows material of less value arranged with less art while at many points walls of the first period have served as underpinning for those of the second Finally much later following a new destruction (second or third century A D) the city was rebuilt but with walls narrow and inferior showing the poverty of the place which was constantly ravaged by the barbarians till its final overthrow which the study of its money and pottery shows to have occurred about the fifth century after Christ For a thousand years or more the very existence of the ancient city was unsuspected the medieval city clinging to the flank of the hill where a modern village has replaced it

It must be noted that among the Roman ruins were found the remains of Gallic huts usually slightly sunk in the soil and built of baked clay The fragments found show the precise method of construction

Wattles were built of peeled branches in the exact outline of the proposed edifice On each side of this structure was applied a thickness of several centimeters of clay and the whole was then baked by fire applied both within and without Thus the wood was carbonized and the earth transformed into solid baked clay

Wells cisterns and aqueducts exist in considerable numbers on the plateau and many of these excavated to the rock yielded innumerable objects preserved intact

Among these may be mentioned bronze caldrons a jug with its tray a perfume vase a wooden bucket bound with iron and bearing a meter's length of chain and finally a wooden musical instrument

This last object is the most precious of all for it is nothing less than a genuine pipe of Pan and is absolutely unique no other example having descended to us from antiquity

Beautiful bas reliefs and statuettes have also been found It was first the Capitoline Triad—Jupiter between Minerva and Juno which marked the importance of the monument with three apses where it was found then one of Castor and Pollux one of the Heavenly Twins being in good condition while of the other only the head and some fragments of the horse were found

Of special importance is a mutilated statue of a Gallic chieftain showing the apparel the tunic, and a sword belt to which a short sword was attached by thongs.

Other articles are an Amazon a Jupiter a divinity with [illegible] which recalls certain Germanic Gods a life size head of a woman goddess or empress and above all three heads with closed eyes of negroid type which are all perhaps the [illegible] of Hercules said by the ancients to have brought negroes and to be the founder of Alesia

Then too a curious Epona goddess of horses and stables was brought to light as also a small plaque of bronze of the same divinity minus a head

Of the numerous pieces of pottery some are beautiful and one bearing an image of the god Mithra really remarkable

Perhaps the most interesting of the Gallo-Romanic ruins is the great theater with a facade of over 24 meters placed against the side of a hill Behind is the substructure of a temple Beside the walls is the base of the altar where the priest stood outside in a space limited by a portico where the worshipers

Further to the east was the great monument with three apses which contained the temple and made part of the same architectural ensemble This seems to indicate a pagan basilica adapted at the dawn of the middle ages to the uses of the Christian faith At the north of this monument is found a vast quadrangular structure whose facade contains a double row of columns placed at different levels It was near this that there were found in a house which must have been used as a workshop troughs and fragments of mills which indicate the nature of the industries of Alesia

In the sixth and latest excavation a vase was found which is a most beautiful example of these arts

To the east of the monument of three apses is the forum bounded at the north and south by columns the bases of whose pillars are still visible Ruins of many houses are found in some of which the hearths are still filled with ashes

According to Pliny Alesia was the seat of a famous industry plating and silvering especially the making of arms and equipage of silver Such an *industrie de luxe* of course shows a high degree of civilization

Reinach sees in this a correspondence to the Celtic art of enameling which existed at Bibracte The passage in Pliny relating to the metallurgic crafts of Alesia has been corroborated by recent finds particularly a mirror of bronze lined with lead and some of the utensils of the bronzemakers consisting of troughs and crucibles of refractory earth in which the bronze was melted and fragments of mills of baked clay into which the metal was poured to be cooled according to a process still in use at the present day

A museum will shortly be opened at Alise for the display of these relics.—Abstracted from Le Monde Illustré for the SCIENTIFIC AMERICAN SUPPLEMENT

THE PROCESSES IN COTTON SPINNING.*

A REVIEW OF AN INTERESTING INDUSTRY.

BY LEON A. HACKETT, S.B., '04.

The cotton manufacturing industry of this country has an annual production of nearly half a billion dollars value 33 per cent of which originates in the State of Massachusetts alone The industry while expanding as a whole to meet future requirements has nevertheless fallen off in Massachusetts during recent years in its percentage growth when compared with other sections of the country and indeed with the prospect now that the center of the industry will eventually move to the South

The increase of fixed capital in fact during the past eight years for Massachusetts has been but about 20 per cent while for the South in a corresponding period the increase has been well over 140 per cent† This shows that the manufacturing output for home and export trade is far from being abreast with the demand for goods and further indicates that the deficiency in production of this principal staple manufacture of the State is to be supplied from another locality

With a view to giving some general idea of the manufacture of cotton an industry in which Massachusetts has long been foremost the following is presented being however only an outline of the operations in that branch of cotton manufacture concerned in the production of cotton yarn from raw cotton To the average reader unacquainted with the manufacture of this particular staple an explanation of cotton spinning as a whole is of first importance one that does not enter elaborately into details but gives a notion of what is accomplished in the factory and what machines and materials are used and what principles are involved in the various stages of progress In such an explanation as this there will necessarily be introduced some few technical terms peculiar to the particular process described without which the explanation would be less intelligible

In the spinning of cotton yarn there are five processes or really five types of machines through which the cotton must pass in its manufacture into yarn These processes are the picking the carding the drawing the process using the machine called a roving frame and the final process of spinning proper

PICKING

The picking process which is the first to handle the cotton has two purposes first to clean the cotton of its broken leaf sand and very short fibers and then to prepare the cotton into a suitable shape to be treated in the next process of carding Four machines are used successively to do this which are shown in Fig 1 in the order of their working as feeder breaker picker intermediate picker and finisher picker

Cotton as received at the mill comes in the form of bales approximating 500 pounds in weight compressed to about 16 pounds per cubic foot From this previous treatment the fibers have become pretty well matted together and when they arrive at the mill and are opened up they do not return to their natural fluffy state without considerable mechanical handling

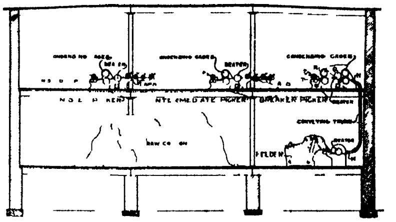


FIG 1

The feeder (Fig 2) which is the first to operate after the sacking and bale ties have been removed is designed to break up the cotton into comparatively small pieces from the large matted ones that are thrown into the machine hopper by hand from the mixing pile The large pieces get tossed about in the feeder and come finally into contact with the spiked travelling lattice A B moving up the side of the hopper box [illegible] which they are carried forward by the other lattice C D moving along the bottom As the cotton is carried forward to the spikes some pieces are caught there of larger size than permit their passing by at the space E and in consequence are knocked back by the revolving spiked roll F Later these pieces again repeat the climbing up operation until the stock has been so disintegrated that it is all enabled to pass on It will be noticed that this knocking back of the large pieces of cotton during the action of the feeder is virtually a regulating action to the supply The cotton next enters what is called the beater chamber at G

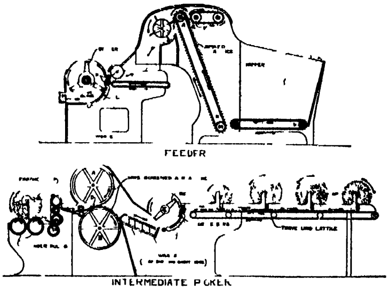


FIG 2

This is a cylindrical chamber containing the beater H which is the vital part of the machine In construction the beater is simply three parallel bars fixed and so bolted securely to arms about a center that they may be revolved at a high speed of 1500 revolutions per minute As the cotton is fed out from the rolls at K it immediately comes in the path of these revolving bars and in so doing is dashed down against some grate bars at I These bars are so arranged that while the cotton is opened up by them the heavier impurities like sand broken leaf and seed are also driven off and out between them while the main bulk of the cotton passes on into a pipe or trunk M

A suction fan is the means used to send the cotton on through the trunk to N (Fig 1) where the cotton arrives at the next machine usually located on the floor above called the breaker picker In this machine the cotton undergoes four distinct operations the first of which might be called a condensing action as the cotton enters from the end of the trunk then there is the one of beating as before in the feeder following this another condensing action and lastly the formation of a lap The condensing action will be more clearly shown by reference to Fig 2 the intermediate picker machine

Two horizontal screened cylinders called cages (A and B) here revolve in opposite directions about twice a minute The length of these cages is 40 inches and their ends are so mounted in the sides of the machine that by means of an air-duct not indicated leading from the ends of the cylinders to a suction fan a pressure slightly below atmospheric is produced so that the cotton as it enters the chamber C is at once attracted here to cover up the slowly moving screen surfaces At the point D as the cages continue to turn, the seal of the air chamber is passed, and the cotton peels off in the shape of one thick ribbon from both screens. In the breaker picker (Fig 1) this condensing action is the same

Now we will return to the point where the cotton from the trunk M passes on to N Here it is condensed momentarily into a short ribbon (P) then an instant or so later it enters the chamber Q to be broken up by the beater and finally is condensed again at the cages R when it peels off into a ribbon at S It passes now in and out around some heavy rolls and is wound up in a roll at T In this form of a roll [illegible] cotton is called a lap being a huge wound up [illegible] cotton 40 inches wide 50 inches or more in [illegible] weight from 40 to 50 pounds [illegible] two operations in the feeder [illegible] cotton is somewhat the [illegible]venient for handling, [illegible] formed in the [illegible] and placed on [illegible] intermediate [illegible]her pass on [illegible]re dirt and the[illegible]e at the front of the [illegible]

The abo[illegible] series of operations of the pi[illegible]r further cleanliness and for unifor[illegible]p the intermediate picker and the next ma[illegible]o follow, called the finisher picker are used

CARDING

The treatment of the cotton in the carding process is one tending toward the individualizing of the fibers that is a process where the cotton is so closely dealt with that the fibers may each be said to have been separated once during contact with the operative part of the card The process by which the fibers undergo this minute handling is of the nature of a brushing or combing action where all the fibers are subject alike to the same treatment with combs This brushing action too instead of being repeated over and over again is continuous and the fibers are held fast at one end during the treatment only through embedding in the bristles or teeth of one brush while another performs the combing or individualizing The degree to which the fibers are actually individualized into what might be called parallel order such as will be needed later for the formation of the thread is probably very small but they are sufficiently loosened up here to adapt themselves readily to this order in the next operation

The combing action as used in the card, is indicated in Fig 3 where the bottom comb or carding surface A of the cylinder acts as a carrier of the fibers bodily forward, to meet continually new clean bristles, or teeth, of the top comb or flats and also to hold the fibers sufficiently embedded in the teeth so as not to slip by easily from one tooth to another during the operation here When the cotton fibers are placed between the two brushes or carding surfaces of the machine of this process, the straightening and isolating action is at first a gradual one as the brushes move by one another, but after contact with the upper brush has continued for a moment, there comes a distinct betterment in the order of the fibers It will be seen from the figure that the spaces between many of the teeth of the upper surface are filled, or partially filled, and the representation here is that of the [illegible]

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* Harvard Engineering Journal

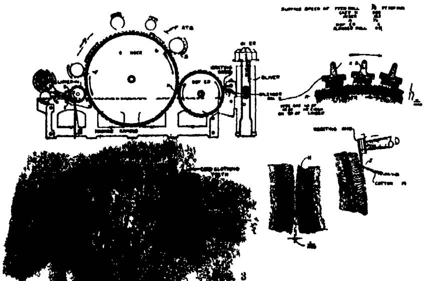
† Census Report, Bulletin 97 p. 10. This does not include 1905.

[illegible] short fibers, which have been caught in these upper carding points of the flats as they are called These fibers constitute undesirable stock, which should be removed from the cotton, as they would work poorly in the spinning operation later The reason why these short fibers in the flats are detrimental to the finished yarn is that they are the immature cotton fibers, which are always present to a more or less degree in all grades of cotton and as such do not possess the convolutions or twists, in the individual fibers that the ripe ones do These convolutions, or twists, in the fibers serve the purpose of interlocking with each other and by so doing give the strand some appreciable strength (see Fig 9)

An arrangement in the carding-engine provides for the removal of the short fibers through cleaning the flats as they turn, in course of their slow rotation out of contact with the cylinder at about the point *B*

A general description of the card may now be given and the passage of the cotton followed through the machine at the same time A card as used in cotton manufacture, is a machine that has many of its active contact points concealed from view so that when observed casually its means of operation are not at all apparent In Fig 3 a sectional view is given and also enlarged sections of operative parts connected therewith

The form in which the cotton is received in this process has already been stated as that of a broad rolled up ribbon of cotton or a lap and now as it leaves the card it takes the form of a strand an inch or more in diameter From the lap that is fed into the card each yard is turned into from 100 to 120 yards of cotton strand of soft rope form this number of yards with corresponding diameter being governed largely by whether the ultimate yarn is to be a coarse or a fine one



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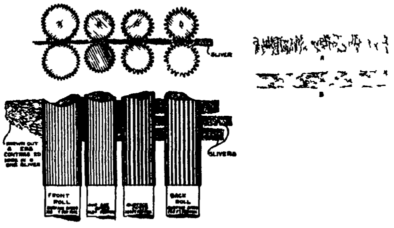
The lap is placed at the back of the card and unrolls along the feed plate *C*, until the end of the lap reaches the point *D* At this point the cotton is snatched away in small tufts by the saw-toothed surface of a cylinder, revolving very quickly which is called a licker in These little tufts of cotton which the saw teeth pick off are dashed down against some grate bars or knives, at *E* and at the same time any dirt still retained in the lap is driven out between the bars. The licker in saw teeth also throw the fluffy cotton down farther upon the cylinder where it at once adheres, through the action of induced air-currents At the cylinder the operation of the card may be said fairly to commence the licker in being essentially a feeding and opening up arrangement preparatory to the carding of the cotton proper This main cylinder and operating part is usually about 50 inches in diameter and 40 inches wide and is made of cast iron and provided with an axle for its rotation It is also covered with a so-called card-clothing the action of which is the direct means for combing and separating the fibers In appearance the card-clothing is somewhat like a music-box cylinder, only the points on the latter are spaced far more coarsely than those of card-clothing on the card-cylinder An enlarged section, given in Fig 3, shows plainly the clothing teeth, as attached to the cylinder the flats and the doffer, and also the relative positions of these teeth when the cylinder is working against the flats or the doffer The number of points in the card-clothing runs about 65,000 per square foot, and on the basis of calculated surface-speeds, there are from 10 to 15 points presented for every fiber that passes through the machine, and this, in view of the purpose of the card to individualise the fibers, would seem to be a ratio sufficient to have some effectiveness

Starting now at the point where the cotton is caught on the cylinder, we notice that it is carried immediately in the opposite direction a short distance before it comes under the action of a number of flats that teeth combing at *F*, Then from *F*, the cotton is carried forward while embedded in the cylinder-teeth from one flat to another until at *G* the action of the flats ends Notice will have been taken of the close setting of the flats to the cylinder from Fig 3, so close that any fibers placed between flats and cylinder must needs be torn apart or individualised by the action of so many teeth After being carried by all the flats by the cylinder the cotton continues a short distance farther to *H* and then another smaller cylinder comes into operation acting as a sort of stock remover to the large cylinder



DRAWING ROLLS

Fig 4

This smaller cylinder which is placed almost up to tangency with the larger one is called the doffer and its only purpose here is to transfer the cotton from the main cylinder to this smaller one The principle by which this transfer is accomplished is a trifle puzzling as both the actions of surface speeds and combings are involved The large cylinder turns at 160 revolutions per minute or has a surface speed of about 2 100 feet per minute the doffer 27 inches in diameter moves about 10 to 12 turns a minute or with a surface speed of about 72 feet This means that 29 inches of surface of the cylinder all laden down with loosened fibers pass by for every single inch of surface of the doffer that moves away from the point of tangency The inclination of the doffer cylinder teeth being favorable to receive the fibers from the cylinder and the distance between the two cylinders only 7 1000 of an inch the transfer is readily effected so that the doffer practically backs off with the fibers that are thrown upon it and moves away with them to the point *J*

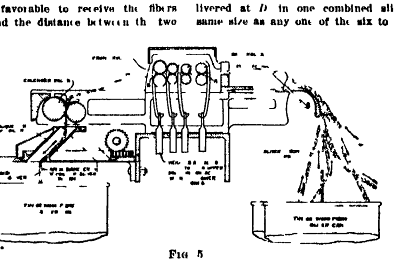


Fig 5

Here a vibrating comb acts to clear or knock the fibers off from the doffer in quick little raps and they peel off in the shape of a broad transparent film of fibers. The film is drawn out a short length when it is contracted into a funnel-shaped piece which brings the cotton to the form of a strand Then in the form of a strand, the cotton passes through some calender rolls to be slightly compressed and into a coiler where a means is provided to pack the strand away, in the shape of circles or coils in a can for the temporary disposition of the fibers until withdrawn again later in the course of manufacture

DRAWING

In this process the cotton is received in the form of so-called sliver from the card and after having been operated upon it leaves the process in much the same form in which it was received Indeed it does not appear from a casual inspection to have been changed at all by the action of drawing If however, several individual 1 yard lengths of the sliver were weighed their respective weights might be say 55 51 9 and 1 grains each per yard an average of 54 with a maximum variation of [illegible] grains from the average Then at the end of the process any other four yards measured off at random would likely have weights 40 41 42½ and 40½ an average of 41 with a variation of 1¼ grains from the average

The result of the drawing and one of its main purposes here has been to reduce the extent of the variations in weight it being immaterial as will be seen later whether the full weight of the sliver is 40 or 50 grains in itself Beyond this added uniformity of the strand there is another benefit derived in the operation of drawing which might be termed the parallelization of the fibers At the beginning of the process the fibers of the strand from the card were crossed in every direction along its length just as they were beaten off from the doffer cylinder by the vibrating comb Now in drawing these fibers become placed in very close alignment to one another in fact an extreme case of the arrangement of the fibers would be represented in Fig 4 where *A* shows the crossed positions of the fibers *B* the relation of the fibers after having passed through this operation of drawing Three machines are required to bring about the required uniformity of the strand and to parallelize the fibers all of which are of the same type the operations being merely repetitions of one another in different machines

In Fig 5 is shown an end sectional view of a draw frame also in Fig 4 on a larger scale the four pairs of fluted rolls *A B C D* These latter are what do the drawing The upper rolls move from contact with the under ones while the latter are positively driven by gearing on their ends

Six slivers from the card are passed in at *A* and through accelerated surface-speeds of the rolls are delivered at *D* in one combined sliver of about the same size as any one of the six to enter There has therefore been a drawing action of six to accomplish this reduction in size and by so doing thick variations in one strand will be found to have frequently come opposite thin variations of the other while the resulting strand or sliver becomes more nearly an average of all

At the front of the draw frame an arrangement called a coiler is used the same as that employed in connection with the card and by means of it the sliver is packed away in a tin can in the form of circles or coils in such a manner that entangling is infrequent when it is withdrawn again for later use

A delivery is the unit of capacity of the drawing

frame and the term refers to the number of finished drawn slivers delivered from the front drawing rolls in any complete drawing frame machine That is when six cans of sliver from the carding process are clustered together at the back of the draw frame and their strands are all united and drawn into one at the front of the draw frame then this is called a delivery Four, five or even six finished drawn slivers are the usual deliveries constructed for draw frame machines depending upon the space or special requirements of the room where in these cases the cans at the back of the machines would be 24 30 and 36 respectively in number

(To be continued)

Correspondence.

ESPERANTO VS IDO

To the Editor of the Scientific American Supplement

In the Scientific American Supplement for May 28th I note an article headed Ido a Third Universal Language with a subhead An Improvement on Esperanto presumably copied from Umschau as one paragraph starts off A writer in Umschau

No doubt you print the article in good faith as a matter of news likely to interest many of your readers but there are so many gross misstatements therein and *it is so evident that you ignorant of the real* facts have been imposed upon by those who are doing everything possible to wreck the international language Esperanto that I cannot permit the incident to pass without strong protest I am one of those who have given the question of an international language much study have thoroughly mastered Esperanto made a close examination of the extravagant claims put forth for this alleged improvement and know whereof I speak Nothing would be easier than to disprove all of the pretensions made in your article for Ido were you willing to accord me sufficient space but as you confine yourself to some bald statements *I shall merely call your attention* to those which are false in the hope that you will be sufficiently fair to present to your readers the other side

You say The Esperanto language thus cannot as yet be considered the solution of the problem The intelligent leaders of the movement are fully aware of this particularly M de Beaufront as a champion of the reform while the inventor Dr Zamenhof himself has approved in very material points Esperanto has been used for almost every conceivable purpose for nearly twenty five years has been found most excellently adapted to its purpose and has more than *500 times as many adepts and supporters as all other proposed languages put together* Dr Zamenhof has NOT approved of any change but on the contrary has never failed to raise his voice against such action pointing out the grave danger of any interference with the fundamentals of the language especially from self appointed committees and individuals who for one reason or another pose as saviors In this position he has the unanimous and enthusiastic support of the Language Committee with its inner Academy to which are referred all questions affecting Esperanto for settlement

It is true that Esperanto has six characters in its alphabet which require special type but French has several also German Spanish and many other widely used languages and there is a most excellent reason for their introduction Furthermore these special characters may be readily and cheaply purchased from any type founder or linotype dealer and in fact are found already in many leading printing establishments

You say Under the circumstances no progress can be expected of Esperanto the paucity of roots is so great Esperanto is a living language in practical use by many hundreds of thousands of people all over the world for pleasure social intercourse and business also largely for the transaction of the affairs of various scientific political religious and other societies and associations of an international character and is growing and evolving precisely as any other language grows and evolves Its original vocabulary was simple as that of any international language with the slightest hope of success must necessarily be but it was entirely sufficient for all ordinary needs and to satisfy the requirements of scientists and specialists in various matters many thousands of words have been added since a dictionary of the same now being in preparation which will contain upward of 100 000

As regards Ido permit me to say that it is merely a plagiarism of Esperanto an imitation with many radical changes none of which can be considered in the light of intelligent unprejudiced comparison as an improvement On the contrary Ido is far more complex has reintroduced many of the alphabetical absurdities and language faults found in French and English and so far from not being exposed to the danger of being supplanted by the creation of a still better and materially different language suffice it to say that up to date no fewer than six former supporters of Ido or Ilo as it is variously called, have become dissatisfied with the language and published books of new systems, each one alleged to be better than any of the others

Esperantists even Dr Zamenhof himself, make no claim that Esperanto is perfect or not susceptible of improvement On the contrary, it is constantly being improved and made more efficient but in the only rational and feasible manner as provided for in the Fundamento There are defects in Esperanto just as there are in English and other languages or in any thing else built by human hands or brain But we are fully cognizant of this that Esperanto has been proven to be most excellent for its purpose by the only logical test that of continued USE that Esperanto is simple easy of acquisition has no difficulties which anyone cannot master with reasonable effort that any search for a perfect language is futile as no two persons can agree as to what constitutes perfection that what is wanted is *agreement between all nations upon SOME ONE LANGUAGE* whether that language be Esperanto English French Chinese or Choctaw that to permit these pompous gentlemen of the self appointed so-called delegation to change the language to suit themselves would at once render valueless the vast literature of our language discourage and disgust the great army of supporters and adepts open the door to any other delegation next year or ten years hence and bring down in ruin the great edifice which we have *labored so long* and strenuously to rect without any compensating advantages whatever

To make a success of this movement one of the greatest and most important in the history of mankind—the sole method is to *sink all personal preferences unite upon some one established and proven language* and say to the world Learn this tongue safe in the assurance that you will not have to discard it and commence all over again six months hence

Charles E Randall

President Seattle Esperanto Society

Seattle Wash

[This letter is one of many which we have received from subscribers all of them ardent Esperantists who fail to realize the purpose of the creators of Ido That purpose is admirably outlined in a recently published book entitled International Language and Science which consists of a series of papers by Prof L Couturat O Jespersen R Lorenz W Ostwald L Pfaundler and F G Donnan Those Esperantists who may take issue with the statements made in our article will do well to read this book

The question of a so called world language is so much in the hands of enthusiasts that it is difficult to form an unbiased opinion concerning it The linguistic aspect of the question has been con[illegible] with so many side issues that the formation of a [illegible] mission consisting of literary and scientific men [illegible] eminent reputation to consider it was necessary S[illegible] an international commission exists in the *Delegat[illegible] pour l'adoption d'une langue auxiliaire internationa[illegible]* After profound researches extending over seven yea[illegible] the delegation has shown that a sound idea lies at t[illegible] root of the various movements for a universal language but also that neither Volapük nor Esperanto has succeeded in solving the problem As however Esperanto was found to contain many excellent features the commission finally resolved to work out on purely scientific principles an international auxiliary language on the basis of Esperanto It is this language which our Esperantist friends repudiate, without realizing in our opinion, the purport of its creators

It is far from our intention to attack Esperanto Dr Zamenhof performed a wonderful work when he created Esperanto at a time when the question of an international language had ceased to interest humanity and succeeded in producing a tongue which despite its defects is decidedly superior to all previous attempts and which has proven itself a serviceable though not ideal means of international communication

It is unfortunate that many of our subscribers regard the Marquis de Beaufront as a renegade from the Esperanto movement It should not be forgotten that it was through the Marquis's efforts that Esperanto became widely known in France His disinterestedness is shown by the fact that he gave up his own invention Adjuvanto as soon as he came to know about Esperanto If he has allied himself with the delegation it must surely be for sound philological reasons

The distinguished chemist, Wilhelm Ostwald has given an account of the work of the delegation The commission consists of representatives of the English, German Italian Scandinavian and Slavonic languages Famous philologists scientists and philosophers have given valuable assistance Concerning the work done Ostwald writes 'Although the labors were very *fatiguing* they proved all the more effective for the progressive elucidation of the problem in hand From the very multiplicity of the attempts at a solution, and their discussion, there arose in the minds of the workers, in a manner never to be forgotten a clear conception of the main conditions required for a successful solution of the problem and a recognition of the errors which a disregard of one or other of these systems had produced in the existing system The delegation decided that none of the existing systems fully satisfied the conditions necessary for an international auxiliary language, but that the widely known Esperanto would serve as a basis for the working out of such a language although certain changes were necessary

A standing committee was elected including Ostwald Couturat, De Beaufront and Jespersen, which was intrusted with the task of determining the new forms of the international auxiliary language on the basis of the principles laid down in the sittings mentioned above The changes carried out by the committee of the delegation are embodied in the form of new grammars and dictionaries The delegation succeeded not only in recognizing, but also in correcting in a competent manner the errors of Esperanto with the result that we are to-day in possession of a language which in respect of facility lucidity variety and elegance of expression represents the pinnacle of international speech The new language has been called Ido (that is *a descendant*) because it sprang from Esperanto

The new vocabulary contains in round numbers [illegible] 400 stems and in spite of the Romance character which the international language necessarily possesses forty per cent of these are common to German English French Italian Russian and many other languages Moreover there are naturally numerous other stems which occur simultaneously in four or five of the great languages This simply proves that it is only necessary to select judiciously the words common to the living languages that is to say by an artificial process in order to construct an international language

Esperanto has suffered because it has fallen into the hands of scientifically untrained persons and sometimes into the hands of fanatics Added to this was the desire to soar to the summits of literature instead of confining the language to the practical affairs of life and the truly childish confidence which has led to the spoiling of the classics of different nations by translating them into language intended for other purposes The delegation has labored hard to free the question from all extraneous considerations Naturally the delegation marks therefore without doubt, the beginning of a rational period in the history of the [illegible] language It has taken [illegible] on of the problem [illegible] t hotly attacked [illegible] pro[illegible] Esperanto [illegible] been well able [illegible] Dr Zamenhof [illegible] the influence [illegible] created Esper[illegible] viction that the [illegible] bulary must be obtained from [illegible] Romance and Germanic languages and that the already existing stock of international words must be used he had simply invented his words that is to say, chosen them quite arbitrarily but with as much regard to system and brevity as possible Although he himself noticed that such words are difficult to learn and still more difficult to remember he has unfortunately retained in the finished language a whole series of such formations which appear in words of such frequent occurrence as who how, where never everywhere etc Dr Zamenhof has shown a fondness for sibilants and diphthongs, which is especially evident in the invented words (e g, *chi*, here *chiu* each, *ech* even, *ghi* that, *ghis*, until) Prof Jespersen also points out that Russian usage has inspired such word formations as *esparoli* and *senkulpigi* instead of the international *pronuncar* and *exkusar*

It will probably be conceded by Esperantists that an auxiliary language must be based on the principle of maximum internationality Logical precision of expression is another condition Esperanto has a vocabulary very far from being constructed according to the principle of maximum internationality or logical precision On the other hand, the Esperantists are supposed to make up for this defect by the famous principle of *vortfarado* that is word manufacture, with the result that their language falls into the error of creating idioms For example, in Esperanto the beginning of the sentence, 'A rotary transformer might be called a motor generator, but the latter name is usually applied to machines with independent armatures, is translated in the following way "*Turnighan alispecigilon oni povas nomi motorproduktanto,*" which literally translated reads, "*A self-turning otherwise making instrument can be called a motor producer*"

Esperanto lacks a scientific method of word formation Hundreds of times the puzzled reader of an Esperanto text is in doubt about the sense of an adjective, even such common expressions as "stone" and "made of stone" being rendered in Esperanto by the same word (*shtona*)

The language of the delegation is very capable of expressing difficult passages with all possible fidelity At a time when the language had only just been fixed and when he had had very little practice in its use, Prof Couturat translated into it a particularly difficult passage from the work of Gompers (the Viennese academician) on Grecian Thinkers Prof Pfaundler, without having seen the original retranslated it at Graz from the international language into German and sent this to Gompers at Vienna, with the request that he would give his opinion on the accuracy of the retranslated passage Gompers wrote, characterizing the reproduction as astonishingly exact the test as extraordinarily successful, and the result in a high degree favorable to the possibility of employing the international language This test must certainly be regarded as a very severe one because the German language is foreign to the first translator while owing to its philosophical nature the subject was not familiar to the second translator as a physicist

Finally it may be stated that Ido the new language is not perfect by any means Like every other human invention it is perfectible Without doubt it will have to undergo changes and improvements for one cannot expect that such a gigantic task as the introduction of an international auxiliary language can be accomplished all at once Ido however represents the first artificial language whose introduction to science deserves serious consideration

We would urge Esperantists to cooperate with the delegation in solving the very important problem of providing the world with a language which shall be truly international They can be of great assistance in this effort because they are familiar with Esperanto and ought to be able to speak the new language with very little effort —EDITOR]

METEORS AND THEIR OBSERVATION.

HINTS FOR THE AMATEUR.

BY W. F. DENNING, F.R.A.S.

THE observation of meteors forms an important branch of practical astronomy and it is one which specially commends itself to the amateur astronomer It merely needs patience and the keen use of one s eyes The only instrument required is a celestial globe on which the apparent paths should be pencilled as observed The R A and Dec of each meteor should be recorded together with the date time magnitude duration length of path streak or train and assumed radiant A few years watching on clear moonless nights will yield some thousands of meteors and if they are carefully observed and accurately registered the student may feel satisfied that he has accumulated materials both of an interesting and valuable character

Of course a certain amount of practice and experience are essential before a beginner can expect to attain precision and reliability in this work Many months of sedulous application to it can alone insure success The writer concluded that the observation and record of 2 000 meteors are nec[illegible] before desirable proficiency can be expected [illegible] certain that much depends upon individu[illegible] [illegible]er tain cases a very extended practi[illegible] insufficient to impart the deg[illegible] —in fact a proportion of [illegible] the skill or natural abilit[illegible] searches In other inst[illegible] quaintance with the wor[illegible] factory results [illegible] searches obviously [illegible] the observer s intuit[illegible] will enable much to [illegible]ree of skill attained m[illegible]tude of the individual

Meteoric observa[illegible] dependent upon somewhat ro[illegible]-eye estimates of position The ph[illegible] has practically failed to realize anticip[illegible]sults hither to have been very meager, only the[illegible]ils of brilliant meteors appear to impress themselves on the plates We have still to regard the unaided eye as the main factor in providing us with materials

This is to be greatly regretted for so long as the old method is employed we shall continue to hear complaints as to the inaccuracy and uncertainty of meteoric astronomy These complaints are in a measure just for a large proportion of our existing data is rendered almost useless by errors which cannot be eliminated Considering however the difficulties confronting the observers and the character of the work I believe it to be more correct than is supposed and that if certain obviously wild results were expunged from our catalogues, it would be an advantage

The plan of recording meteors and shooting stars initiated by Heis Schmidt, and others has admittedly borne good fruit We have learned the average heights of meteors The Leonids begin and end their luminous careers at elevations of 84 and 56 miles respectively They are the swiftest and highest class of meteors. The Perseids are usually from 80 to 54 miles above the earth's surface The slow moving meteors are usually much lower in the air

We have also learned something as to the vast number of very feeble meteoric streams scattered over the heavens, and many hundreds of their radiant points have been ascertained Many of these require reinvestigation The great majority of known showers may be said to be remarkable for their tenuity Apparently, they return every year and endure for several months, and from stationary centers of radiation. These are facts in support of which it would be satisfactory to have more ample evidence

An immense amount of useful work yet remains to be accomplished in meteoric astronomy It is not a subject that will ever be exhausted It presents us with many interesting variations from year to year A shower will be absolutely quiescent at one time and twelve months later may present us with a splendid exhibition The Andromedids of November furnish a good example of rapidly varying strength and the Leonids may be classed in the same category The Perseids of August seem to be more consistent and equable in their annual manifestation if we take moonlight cloudy weather etc into account for such differing conditions must introduce large variations in the observed strength of the display

Any person intending to occupy himself in the meteoric field cannot do better than maintain a sharp look out on ordinary clear evenings and record in a book properly ruled for the purpose the apparent positions etc of the objects observed There has been too much selection in the past By this I mean that while the April August and November epochs have been pretty thoroughly investigated and the special showers prevailing at those times viewed again and again the other seasons not signalized by rich systems have been much neglected The reason of this is obvious Many people find it too tedious to stand [illegible]t in the open on a cold winter s night and watch [illegible]tors falling at the rate of eight or ten per hour [illegible]ile there are plenty of volunteers to witness the Perseids furnishing from [illegible]0 to 100 fine meteors in a similar interval What we require is careful observation at times of the year which have never received adequate attention Approximately the winter and spring months display only half the number of meteors which appear in the summer and autumn and this is quite irrespective of special systems We need more data for each of the first six months of the year though April skies have already been pretty thoroughly explored

The direction and position of the meteor flights form the most important features to be recorded with exactness for unless this is done the radiant points cannot possibly be correct Such points ought to be determined within 2 deg of probable error and at least five paths should be well conformable to any position before it can be safely accepted

It has been said that the chief periods of meteoric activity in August etc have already been well studied but our knowledge of the leading displays is by no means complete If we would learn the history and nature of the variations affecting such streams as the Leonids and Andromedids we must witness all their annual or periodical appearances The Andromedids returned actively in 1872 1885 1899 and 1904 while the Leonids were moderately numerous in 1901 1903 and 1904 No one can say whether the Leonids display a stationary or moving radiant though the shower is certainly in visible evidence between November 7 and 19 The shifting of the Perseid radiant is already sufficiently proved, but the Lyrid shower of April requires more investigation upon this point as the display is often feeble and of very brief duration

Meteoric astronomy is a department which cannot be as exhaustively dealt with as some other sections of the science Like the cometary world it supplies new and brilliant objects which are often unexpected Our knowledge of double and variable stars nebulæ solar lunar and planetary details is pretty good as a result of the telescopic work of three centuries but there is a relatively unceasing supply of large comets and meteors from without which render important discoveries of conspicuous objects still possible Thus a brilliant and unknown comet came quite unannounced last January In the allied domain of meteors we had the splendid fireballs of February 17th and 28th last, so well described by your correspondents

The one of February 28th appears to have been widely observed and descriptions of its aspect and course have reached me from places so distant as Steppe near Glasgow and Salisbury in Wiltshire In every collection of miscellaneous data of this sort there are discordances which serve to render their reduction a rather difficult process and it may be well to await further information before drawing final conclusions One thing however appears certain and that is the meteor s exceedingly low position in the atmosphere at the moment of its final disappearance At Kington Hereford the observer says it appeared to touch the horizon though he was situated [illegible]0 feet above sea level At Leeds its altitude was estimated at only three degrees at the finish while in Gloucestershire it was given as two degrees Probably it was only sixteen miles high possibly only ten or twelve when it ceased to be luminous at a place over Ireland about thirty miles south of Cavan English Mechanic and World of Science

RESINITE COMPOUND

CONSUL THOMAS H NORTON of Chemnitz says that various art industries in Germany have found a number of useful applications for a newly invented substance termed resinite of which he gives an account

This material is produced in a variety of modifications by the union of formaldehyde and carbonic acid (phenole) in connection with certain metallic salts The name is given on account of its resemblance in an important form to ordinary resin This special variety is used chiefly with porous materials such as wood paper pasteboard etc and renders them hard and impermeable Thus ordinary pine wood when thoroughly impregnated becomes so hard that it rapidly dulls a planer

In another form it can be poured as a liquid into molds After coagulation it is transparent with ruby tint infusible and unaffected by ordinary chemical reagents It is well adapted for making ornaments such as hat pin heads imitation jewelry and for most purposes where enamel or enamel varnish is employed For doorplates street numbers signs etc It seems capable of rendering excellent service being entirely unaffected by atmospheric action

A third modification is liquid but upon the additions of a mineral acid it solidifies in a few minutes to an elastic homogeneous substance which can be easily cut turned polished etc In this form resinite can replace for a multitude of purposes horn celluloid vegetable ivory and similar substances Buttons knife handles mosaic designs are some of the many objects made with this modification When competing with celluloid it possesses the great advantage of being noncombustible This property resinite shares in common with another industrial rival of celluloid viz cellit (described in Consular and Trade Reports in 1908)

There is a large field for this new material in the glove manufacturing sections of Germany where at present clasps are made chiefly from vegetable ivory

The smallest engine in the world says the Sibley Journal is named Tiny Tim The cylinder is of steel with a bore of 0 03 inch and a stroke of 1 32 inch It makes 6 000 revolutions per minute developing 1/489 000 of one horse power At full load at this speed, the eye can detect no motion of the parts but it produces a hum like that of a mosquito Seventeen parts complete the engine the net weight of which is four grains One hundred such engines would weigh one ounce The bed plate is of gold with inserted, hardened and ground self oiling bearings

ELECTRICAL NOTES.

When an electrolytic cell of the aluminium type containing a solution of a borate as electrolyte has been in continuous operation for some time, an objectionable deposit is liable to be formed on the plate. In an invention recently patented this deposit is in great part suppressed, and its injurious effects are reduced by the addition of tartrates to the electrolyte. This also improves the character of the film in cutting down the leakage current and in raising its critical or breakdown voltage besides reducing the resistance of the electrolyte. The solution may be made by mixing six parts of boric acid and one part of tartaric acid and then approximately neutralizing the mixture with ammonia or other alkali, or a tetraborate may be used instead of boric acid. In some cases it is preferred to add also about 10 per cent of glycerin, and in a modification of the invention the acidity thus produced is neutralized or partly neutralized by again adding alkali.

The New York, New Haven and Hartford Railway has recently put into operation the first regular multiple unit train service between Port Chester and New York. The present equipment consists of four motor cars and six trailer cars. The car bodies are 70 feet long and each has a seating capacity for 76 people. No wood is used in the construction. Each motor car weighs 173 400 pounds complete and is intended to haul two trailers each of which weighs 99 000 pounds. All cars are provided with quick-acting automatic air brakes. The cars operate on 11 000 volts alternating current overhead and 600 volts direct current third rail. The electrical equipment of each car consists of four six-pole 1[illegible]0 horse-power single-phase series motors which are geared to spring-supported quills. The quills are connected to the driving wheels in the [illegible] as are the quills on the New Haven gearless [illegible] motors are connected four in series or two [illegible]ies and two in parallel when operating with 600 volts direct current. On alternating current they are permanently connected two in series and two in parallel. The multiple unit system is used and a complete motorman's equipment is placed at both ends of every car, trailers as well as motor cars, so that the train can be operated with trailer cars in front if so desired.

According to the Electrician, a meeting of the Sub-committee of the American Railway Engineering and Maintenance of Way Association was recently held at which reports of the Committee of the American Railway Association on the standard position of third rail working conductors were discussed, and while no conclusion as to the amount of clearance which it would be advisable to recommend was agreed upon, it was the feeling of the Sub-committee that the clearance between the limiting lines of third rail structures which are shown as in 1½ inches in the report referred to are insufficient and that a greater clearance should be established. In order to determine the limiting clearance that should be allowed it was decided to secure data showing the limiting lines of clearances of third rail conductor structures, the limiting lines of rolling equipment and the limiting lines of the third rail structures with respect to maintenance of way structures on various railways. The Sub-committee is also collecting data from various electrified or partly electrified lines and also interurban lines with heavy traffic which may possibly interchange with steam lines electrified or non-electrified. The Sub-committee is communicating direct with representatives of the various railways and a circular has also been issued by the secretary of the Association requesting data pertinent to the subjects outlined.

ENGINEERING NOTES

According to the Engineering Record, an oil separator made from an old Pintsch gas tank recovers daily from 4 to 5 gallons of oil contained in the leakage from condensing engines and feed water pumps at the power station of the Metropolitan Elevated West Side Railway, Chicago. The drip from the machines is carried by grooves in the concrete floor to a center drain from which connection is made to the bottom of the 150-gallon tank, the latter being below the basement floor level so that it is under a head of about 3 feet. The outlet pipe also joins the tank at its bottom and is carried up about 3 feet at the end opposite to the inlet so as to form a trap. The comparatively slow velocity through the tank allows the oil and water to be separated, the former rises to the top of the tank where it is trapped and the latter flows out through the discharge pipe. Gages show the relative amounts of oil and water, and the oil is drained out at intervals through a pipe connection with a stopcock under which a pail may be placed.

A report of the Committee on Rails of the American Railway Engineering and Maintenance of Way Association includes a new form of specification. In summarizing the results of experience thus far gained with the new rail sections of the American Railway Association the report states that experience with the heavy base sections has been disappointing. The Committee also state that so far as they are aware no railway company has purchased rails under specifications approved by the American Railway Association and referred to them, neither do they know of any American railway that has succeeded in buying rails during the past two years according to a specification entirely satisfactory to the railway company. The committee's experience has brought to their attention some defects in all the specifications and acting under the impression that there is a distinct feeling that the specifications should be revised they offer the fresh specifications referred to. Hitherto the Association have had no specification for open-hearth steel rails and one is now included.

J. W. Buzzell and W. H. Larkin in the Engineering News describe some experiments which were undertaken to devise an arrangement for the mechanical conveyance of concrete. The ordinary method is to convey it by wheelbarrows, carts, cars, buckets, chutes, etc., requiring enormous cost in outlay for runs, trestles, railways, engines, derricks, etc. The device used in the experiments consisted of an iron tank provided at the top with an air-tight gate on the side with a pipe entrance for the compressed air and [illegible] the conical bottom with an exit pipe for the co[illegible]crete. Concrete was first mixed on a board at the to[illegible] of the hopper and poured into the tank through the upper gate which was then battened tight. Simultaneously then valves on the intake air pipe and the outlet concrete pipe were opened and the compressed air forced the concrete out of the tank through a 4-inch pipe to the point of exit. The 4-inch pipe was about 400 feet long and contained several 90 deg. bends and one 180 deg. bend round a 4-foot radius. It was found that 50 pounds per square inch pressure was the most efficient. Under this pressure the concrete mixture was forced out of the end of the pipe in a well-mixed mass but at a velocity too great for practical work. To reduce this velocity a nozzle was devised. The main object of the experiments was to determine the amount of power necessary to convey concrete through pipes of different sizes and lengths and the coefficient of friction between the concrete and pipe so as to make possible the use of Bernouilli's theorem in the design of other apparatus.

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TRADE NOTES AND FORMULÆ.

To Increase the Durability of Glass Lamp Chimneys.—Pack them wrapped in straw, in a pot, pour cold water on them and place the pot on the fire until it boils. The fire is then let out and the pot allowed to cool.

Bronze Fluid.—Dissolve 10 parts of aniline red and 5 of aniline violet over a water bath in 100 parts of 96 per cent spirit, adding 5 parts of b[illegible]ic acid and boil five or ten minutes or until the greenish color has changed to a light bronze brown. Applied with a brush this fluid gives a splendid bronze effect.

Composition for Roof Tiles (according to Urbanitzky).—Cloth scraps (rags), hemp, straw, wood, refuse of paper manufacturing, animal hair in short lengths, etc., are made with hydraulic lime and water, into a stiff mortar, molded into roof tiles and coated with a mixture of 5 parts hydraulic lime, 4 parts of silicate of soda and 1 part of boiled linseed oil, and finally pressed in a mold under heavy pressure. After drying they should be dipped in hot linseed oil and again allowed to dry.

Black Copies on a White Ground.—A solution of 10 parts gelatine, 10 parts chloride of iron, 10 parts tartaric acid, 10 parts of sulphate of zinc in 300 parts of water (according to the Chemiker Zeitung) should be applied to paper by means of a brush, then dried and exposed to the light under a drawing until the greenish color of the copy paper has disappeared, it is then developed by means of a solution of 20 parts of gallic acid in 1 000 parts of water, to which 200 parts of methylic alcohol has been added.

Curaçao Liqueur, Dutch (according to Campe).—Bitter orange oil 20 parts, oil of sweet orange 8 parts, cumin oil 2 5 parts, oil of Curaçao peels 4 parts, cognac oil 0 5 part, lump sugar good 16,000 parts, potato syrup 1 000 parts, tincture of fresh green orange skins (1 3) 300 parts, spirit (90 per cent) 28 000 parts, adding water to make up 56 000 parts. For coloring use color made from burned sugar. If price is not too much of a consideration use in place of the oil of cognac 1 000 parts of cognac and leave out 500 parts of spirits.

Cupro-Manganese is an alloy of 70 5 parts of copper, [illegible] parts manganese, 0 5 part carbon. Alloys of same: a 16 parts tin, 3 5 parts zinc, 3 5 parts lead, 1 part cupro-m[illegible] 5 16 parts tin, 3 parts zinc, 3 parts lead [illegible]-manganese. Tombac 85 parts [illegible] 1 part cupro-manganese, or 81 [illegible] 2 parts cupro-manganese [illegible], 40 parts lead, 16 parts [illegible]nganese, or 40 parts tin, [illegible]imony, 2 parts cupro-man[illegible]

[illegible] the object with [illegible] with graphite thor[illegible] for use in lead pencil [illegible] hair brush and dry. Th[illegible]tion—gentle rubbing with [illegible]ft bristle brush. In the for[illegible] must be brushed after drying w[illegible]d brush, until a high luster is p[illegible] bristle brush is used, it is to be handl[illegible] bronzing and the polishing can be done with a soft brush or with wash leather. A brilliant luster is thus produced before drying, and subsequent brushing is not necessary. The object is now to be coated with a mixture of 2/3 copal lacquer without much oil, and 1/3 turpentine oil, applied so abundantly that the smooth parts become as bright as a mirror, a second coating of graphite is to be applied, and the object dried at once in a warm place. The first drying must be thorough, but the objects must not be subjected to too much heat, as this would turn the coating greenish. Finally it is coated with wax dissolved in turpentine, wiped with a clean cloth and polished with wash leather.

Black Oxide (J. Rhein).—This is for a steel colored coating. Treat the object exactly as above, as far as to the wax coating, instead of this, put on Prussian blue rubbed up in turpentine oil. Dilute the blue from time to time with wax turpentine or with turpentine oil. It may be very thin, as a little will go a long way.

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A SAWDUST COMPRESSING MACHINE

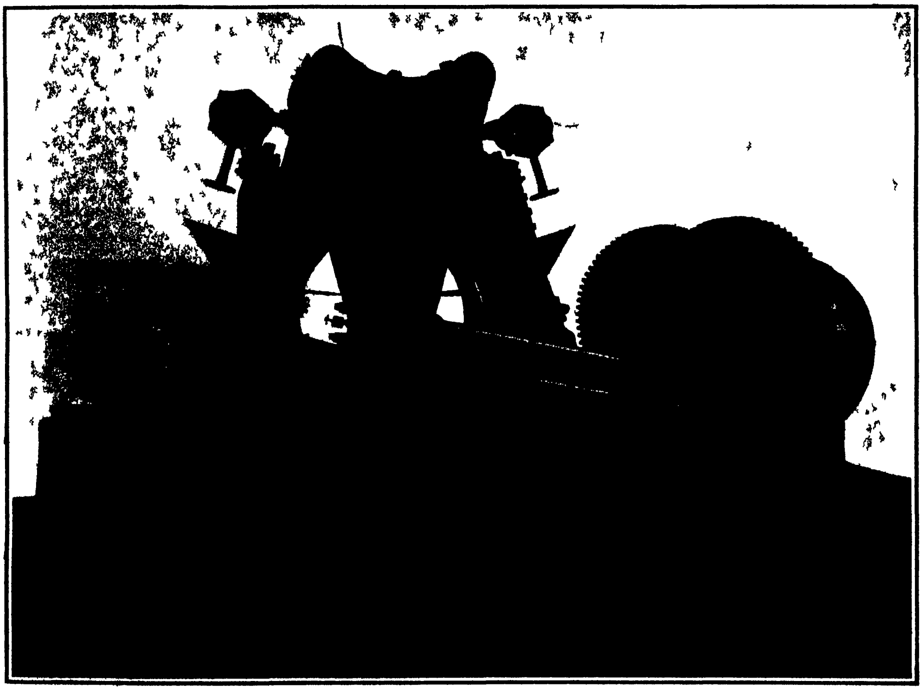
By Charlton Lawrence Edholm

A machine that compresses ordinary sawdust into fuel for domestic purposes has been invented by a resident of Los Angeles and the product is now being marketed in that city

This fuel comes in a very convenient form 3 x 12 inch cylinders These are so hard that a hammer can not dent them and they are clean and dry for the particles of sawdust are not held together by any sticky foreign substance but simply by compression.

The machine shown in the accompanying photograph is equipped with two plungers which force the sawdust through a steel die with a pressure of thirty tons Through the center of the cylindrical die which has a diameter of three inches runs a rough loosely twisted hempen cord, and this forms a core about which the sawdust is compressed, and which serves to keep it from flaking This cord is fed into the machine automatically, and as the hard mass of sawdust is forced from the machine a knife operating by a trigger, cuts it into the desired lengths.

In burning, the sawdust sticks are sootless, and make very little smoke and ashes. There is a brisk demand for this new fuel, and a good price can be obtained for a product of waste matter This machine [illegible] of fire, [illegible] a day, and operates by [illegible]



A SAWDUST COMPRESSING MACHINE OPERATED BY ELECTRICITY

GREAT MASONRY ARCHES

Many stone arches of great size and bold construction were built in the Roman and mediaeval periods Modern engineers employ steel for very long spans but the construction of stone arch bridges of great dimensions is not yet obsolete Among the most notable bridges are the following

The bridge of Alcantara in Spain is composed of six arches two of which have spans of nearly 100 feet. The roadway of the bridge is nearly 20 feet above the bed of the stream which it crosses This bridge was built in the year 98 A D in the reign of the Roman Emperor Trajan

The bridge of Trezzo in Lombardy crosses the river Adda by a single circular arch of 237 feet span and 68 feet rise The radius of the intrados is 137 [illegible] feet and the arch has a uniform thickness of 7 4 feet Its width is also uniform from base to crown This bridge was built in 1370 1377 by the Duke of Milan and destroyed after the capture of the castle of Trezzo by the Count of Carmagnola in 1416

The aqueduct which supplies the city of Washington passes at Cabin John over an arch of 220 feet span and 57 feet rise with a thickness of 20 feet at the base and 9 5 feet at the crown This bridge was constructed in 1860-1862

The railway bridge at Lavaux France crosses the river Agout by a single circular arch of 202 feet span and 96 feet rise. The arch is 5.4 feet deep at the crown This arch which was constructed in 1882 1884 was the largest in France before the completion of the arch over the Valserine at Moulin des Pierres in November 1909

The single arch of the railway bridge at Mont gnon near the lake of Como in Italy has a span of [illegible] feet but little elevation The central arch of the Luxemburg bridge which was completed in 1903 has a span [illegible] 8 feet at its foundation and a span of 36 feet at the level [illegible] feet below the bottom of the keystone at which it separates from the adjacent arches

The railway viaduct at Salcano Austria contains an arch of 279 feet span and 78 feet rise with a thickness of 11 5 feet at the base and 6 6 feet at the crown The total height of the structure above the valley is 105 feet It was completed in 1906

The largest masonry arch in existence is at Plauen in Saxony It has a span of 295 feet a rise of 59 feet and a thickness of 13 feet at the base and 4 9 feet at the crown The radius of curvature of the intrados at the keystone is 344 feet

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Red wax varnish is useful for painting parts of woodwork wires of galvanometers and magnets Small pellets of sealing wax are shaken up with warm methylated spirits and dissolved The viscid liquid is applied with a small camel's hair brush in two or more coats according to the thickness required

RECENT AMERICAN LOCOMOTIVES.*

AN ENGLISH VIEWPOINT.

Two interesting American locomotives of special design built in 1909 are three-cylinder and four-cylinder simple engines, both of the 4-4-2 class for passenger service. The three-cylinder engine of the Philadelphia and Reading Railway has cylinders 18½ inches by 24 inches and driving wheels 6 feet 8 inches diameter. The Walschaerts valve gear is used for the outside cylinders and the Joy valve gear for the inside cylinder. The fire box is 6 feet by 9 feet. This engine weighs 103 tons with 56 tons on the driving wheels. The four-cylinder simple balanced engine of the Chicago Rock Island and Pacific Railway has four cylinders 17½ inches by 26 inches all connected to the first driving axle. The steam distribution on each side is effected by two piston valves on a single valve stem so that there is no complication in valve gears, each side of the engine having a single Walschaerts gear. Superheated steam is used. The driving wheels are 6 feet in diameter and the engine weighs 100 tons with 58 tons on the drivers. The cylinders are placed far enough ahead of the first driving axle to allow of a connecting rod 7 feet long, and this necessitates an increase of 2 feet in the length of the boiler, which is 5 feet 8 inches diameter. The fire box is 8½ feet by 6 feet. The engine is equipped with a Cole superheater.

The use of the Mallet type of duplex locomotive continues to increase to a marked extent, and Mallet engines of some special and unusual designs have been put in service. To increase the capacity of its mountain division with very heavy gradients, in order both to cope with the increasing traffic and to meet the competition of a new line with easier gradients, the Southern Pacific Railway is using some very large sixteen-coupled engines of the 2-8-8-2 and 2-8-8-0 classes. These have cylinders 26 inches by 30 inches and 34 inches by 30 inches, the low pressure cylinders being on the forward steam bogie. The fire box is 6½ feet by 10½ feet, and the 7 feet boiler barrel has a separable bolted joint at the combustion chamber. The tubes are 21 feet long, terminating in a combustion chamber 5 feet long, beyond which is a feed water heater, which is a duplicate of the boiler barrel 5 feet long. In the smoke box is a superheater for the low pressure cylinders only. A hand valve admits live steam to the low pressure cylinders in starting by means of a pipe so small that no reducing valve is required. The Walschaerts valve gear is used and the reversing gear is operated by compressed air. The frames of some of these engines are of vanadium cast steel. The engines weigh about 212 tons, with 197 tons on the driving wheels. Many of the engines use oil fuel, and as these work a line having numerous tunnels and snowsheds, the engines run with fire box in front, the cab arrangement being similar to that used on some of the Italian locomotives. With these very long engines the smoke and gases striking the roof of the tunnel were deflected downward so as to envelop the cab. In order to prevent this action some railways are using a movable hood on the funnel; this is thrown up when the engine enters a tunnel so that the steam and smoke are ejected backward horizontally instead of vertically upward. The tenders of the oil-burning Mallet engines carry 9 000 gallons of water and 2 850 gallons of oil. They weigh 85 tons loaded.

The Atchison, Topeka and Santa Fé Railway has made a decided innovation in the use of Mallet engines for heavy passenger trains, the engines having a tractive effort of 53 000 pounds. These engines have a peculiar wheel arrangement 4-4-6-2. That is, a four-wheel leading bogie carries the front end of the steam bogie, which has four driving wheels. Behind this is a group of six driving wheels in the main frames, with a two-wheeled trailing bogie under the fire box. The boiler is very similar to that of the Southern Pacific engine above described, but has a superheater for high pressure steam and a reheater for low pressure exhaust steam, both placed in a combustion chamber 10 feet long. Beyond this is the tubular feed water heater 7 feet long, and then the smoke box 5 feet long. The boiler barrel proper has tubes 19 feet long, and the fire box is of the Jacob Shupert type described recently in The Engineer. The inside and outside shells are composed of a row of steel channels bent to horseshoe shape and riveted together at the flanges. The grate is 10 feet by 5¼ feet. The usual outside steam pipes from the dome are dispensed with, the pipes connecting with the superheater and coming out near the bottom of the shell. The cylinders are 24 inches by 28 inches and 38 inches by 28 inches, and the driving wheels 6¼ feet diameter. The total wheel base is 52 feet—94 feet with tender—and the total weight is 188 tons, with 144 tons on the driving wheels. This railway is using also a number of Mallet goods engines of the 2-8-8-2 class, with boiler construction as in the other engines. The tractive effort is 108 000 pounds. These engines have cylinders 26 inches by 34 inches and 38 inches by 34 inches, with driving wheels 5¼ feet diameter. The total weight is 230 tons, with 206 tons on the sixteen driving wheels. The boiler—with tubes 21 feet long—has 5 004 square feet of heating surface, 544 square feet of superheater surface, 1 201 square feet of reheating surface for the high pressure exhaust, and 1 617 square feet of feed water heating surface. The grate area is 71 square feet. The tender weighs 112 tons; it carries 4 000 gallons of oil and 12 000 gallons of water. The Mallet engines of another railway are proving so satisfactory that a number of older goods engines of the 2-8-0 class are being converted to the Mallet type with 2-6-6-0 wheel arrangement. The leading bogie and first driving axle are removed, the original cylinders 20 inches by 32 inches remaining as high pressure cylinders to drive the three remaining axles. The smoke box is removed and replaced by a shell containing the combustion chamber, feed water heater and smoke box, and under this extension is placed the new six-wheel steam bogie, with a leading two-wheeled bogie attached to it. This reconstruction is expected to reduce the fuel consumption per ton-mile by nearly 50 per cent. It is to be noted that the huge engines of the Southern Pacific Railway and Atchison, Topeka and Santa Fé Railway noted above are not experimental machines by any means, but that large numbers of the engines are in regular service and giving results that are highly satisfactory. Other railways are using Mallet engines of smaller sizes, and large and small engines of this type—including narrow gage engines—have been built for export to Natal, Brazil, Central South Africa and the U. S. of Colombia. The last is a side-tank engine.

With regard to locomotive machinery, mention may be made of the increasing use of the Baker-Pilliod valve gear. This has no sliding links or blocks, but all parts have positive pin connections, and there are three fixed points in the gear. For engines of all classes the Walschaerts gear is being extensively used, and it is used almost exclusively in the huge Mallet engines. Something new in boiler construction is the Jacob-Shupert fire box already noted, and the Jacobs superheater has been applied to a number of boilers. This latter consists of two drums with horizontal tubes placed in the smoke box, one forward of and the other behind the blast pipe. Boiler steam is delivered to the front drum, is diverted around the tubes by baffle plates, and then passes to the second drum, from which it passes to the cylinders. For tandem-compounds and Mallet engines the steam goes direct from the first superheater drum to the high pressure cylinders; the exhaust is led to the second drum—or reheater—and then goes to the low pressure cylinders. The products of combustion pass through the tubes and around the drums to the front of the smoke box and return through a flue in the forward drum to a draught pipe leading up to the funnel.

There is an increasing use of feed water heaters. The great length of boiler practicable for the Mallet engines makes it easy to use a tubular heater in the manner described. For ordinary locomotives heater drums are placed on or beside the boiler, and are heated by waste steam from the brake pump or a part of the exhaust steam. In some designs also a pipe coil in the smoke box utilises some of the waste heat from the products of combustion. One railway, however, diverts a part of the waste steam into an auxiliary tank in the tender, this being fed automatically from the main tank. The exhaust from the brake pump being generally diverted into the funnel sometimes increases the draught when least required, causing unnecessary fuel consumption. To avoid this one railway has applied auxiliary waste or exhaust pipes, so that the brake pump may exhaust into the open air or into the funnel as may be desired.

In addition to the use of oil-burning locomotives in districts where oil is plentiful, their use has been made compulsory on all railways traversing the Adirondack forest region in New York State. This step has been taken on account of the numerous disastrous forest fires due directly to coal-burning locomotives, in spite of special spark arresters and other precautions. The compulsory use applies only to the summer and autumn.

A new rotary snow plough has been built, which has in front two horizontal drums, end to end, with axes transverse to the rails. On these are spiral blades which throw the snow upward and outward to each side of the railway. The drums are driven by gearing from a 750 horse-power engine running at 300 revolutions, and the velocity of the periphery of the spiral blades is 5 630 feet per minute. The machine is mounted on bogies and weighs 60 tons.

Electric and compressed air locomotives and small tank engines are common enough for mines, works railways, industrial plants and contractors' work, but some firms in America are now introducing small gasoline locomotives for this class of work. In railway motor cars the type in most general use is the McKeen gasoline car, with direct chain drive from the six-cylinder engine to one axle of the front bogie which carries the engine. There are about sixty of these now in use. They are of various sizes, the largest being a 70-foot car weighing 33 tons. The cars are peculiar in appearance, with pointed front end, semi-circular rear end, a door in the middle of each side and large circular windows. To the rear of the entrance is the main passenger compartment. Forward are the smoking compartment, luggage and mail compartment, and engine room. Two types of gasoline-electric cars have been built. The Strang car is 62 feet long, carries fifty passengers and weighs 57 tons. A 150 horse-power six-cylinder gasoline engine is directly connected to an 85 kilowatt generator supplying current to two 100 horse-power motors. There is a 112-cell battery of 300 ampère-hours capacity. The General Electric car is 45 feet long, seats fifty passengers, and has luggage and mail compartments. The power equipment is much the same as in the other car except in detail. These two cars are experimental, but the McKeen car is beyond the experimental stage. Some of the cars are used for branches and for auxiliary service on certain parts of main lines; others are used for secondary railways, or lines of the class more generally operated as electric railways. The electric motor cars for the suburban service of the New York, New Haven, and Hartford Railway are 70 feet long, seating seventy-two passengers and weighing 85 tons. They are entirely of steel, mounted on bogies, with a 300 horse-power motor [illegible] motor is [illegible] is con[illegible] each car [illegible] have con[illegible] 600 volt [illegible] trolleys [illegible] ing cur[illegible] under[illegible] lvania R[illegible] type of design. Each complete unit resembles two four-coupled bogie engines, coupled back to back, making a 4-4-4-4 arrangement. The tractive effort is 60,000 pounds. Upon the main four of each half unit is a Westinghouse 2,000 horse-power motor, taking 600-volt continuous current. Crank arms on the motor shaft are connected by rods to the crank arms on a jack shaft behind the bogie, and from this extend ordinary connecting rods to the fast driving wheels. Thus the center of gravity is unusually high, about 6½ feet above the rails. The driving wheels are 5¾ feet diameter, and the total weight of the complete unit is 166 tons, of which 104 tons are carried by the driving wheels. The requirements are severe, the engine being capable of starting 550 tons of train load on a gradient of 1 in 50 in the tunnels and hauling the train at 30 to 60 miles an hour on the open line. In June, 1909, the Great Northern Railway began operating its Cascade Tunnel by electric locomotives. The tunnel is 13,875 feet long, with a gradient of 1 in 60. Steam service was by two Mallet engines to a train, one at each end, but the operation was dangerous on account of the smoke and gases, and the heat. After each train, 20 to 60 minutes had to be allowed for the tunnel to become clear. A hydro-electric plant has been built 30 miles distant, of 5 000 kilowatts capacity, generating 6,600 volt, 25-cycle current. It is transmitted at 33,000 volts to a sub-station, where it is reduced to 6,000 volts for the trolley line, and then converted by three-phase transformers on the engine to 500-volt continuous current for the four motors. The engines are of the 0-4-4-0 type, with articulated bogies having 5 feet wheels. The gear ratio is 4.26, and the tractive effort 80,000 pounds. The steam locomotives are hauled through with their trains, but eventually the electric locomotives will operate the entire division of 60 miles in length, having gradients from 1 in 60 to 1 in 46.

The electric locomotives for the new Detroit subaqueous tunnel are also of the 0-4-4-0 type; the [illegible] fan-wheeled driving bogies are [illegible] together, [illegible] articulated, so that they take all the [illegible] buffing stresses direct. They are of [illegible] weigh 100 tons, and have four continuous-current motors which have forced ventilation They are 40 feet long and have a tractive effort of 36 000 with a maximum speed of 35 miles an hour The gear ratio is 4 37 The engine is capable of hauling an 1 800-ton train of wagons at 10 miles an hour on the 1 in 50 approach gradients The new electric goods locomotives for the New York New Haven and Hartford Railway are of the 2-4 4-2 class with a two-wheeled bogie carried at the end of each four wheeled driving bogie On each axle is a 300 horse power single phase motor with auxiliary apparatus for operation from the 600 volt continuous-current conductor rail on one part of the line, and the 11 000 volt alternating current trolley wire on the remainder of the line The engine is 50 feet long and weighs 130 tons with 95 tons on the 5¼ foot driving wheels It can haul a 1 500 ton train at 35 miles or an 800 ton train at 45 miles an hour An experimental engine of the 4 6 2 class has two 800 horse power single phase alternating current motors mounted above the frame with cranks and connecting rods to two end countershafts from which return rods lead to the wheels Still another electric locomotive built for experiment has a friction wheel connection to the wheels instead of the usual gears to the axles A 75 horse-power motor mounted between the axles of the driving bogie carries at each end a 12 inch wheel engaging with the treads of one pair of wheels The motor runs continuously and is raised and lowered by a pneumatic apparatus so as to put the wheels in or out of action Tests of this machine in competition with an ordinary geared locomotive having two motors of 35 horse power showed a considerable saving in current

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* The Engineer.

Heavy trains are a prominent feature of American railway service especially where there is a constant and heavy traffic of iron ore or coal On the Virginian Railway built with easy gradients and equipped with powerful locomotives for heavy coal traffic a train of no less weight than 9 120 tons has been hauled by a Mallet engine This was for 120 steel wagons each carrying 55 tons of coal and weighing 76 tons loaded The engine weighs 160 tons tender 80 tons gross total 9 360 tons The standard coal train on this road consists of 80 wagons with 4 400 tons of coal the weight including wagons is 6 132 tons to this must be added 18 tons for the brake van 135 tons for the engine and 80 tons for the tender or a gross total of 6 365 tons. The regular locomotives of these trains are of the 2 8 2 class weighing 135 tons with 110 tons on the 4½ feet drivers The cylinders are 24 inches by 30 inches and the boiler has 4 530 square feet of heating surface with 51 square feet of grate

Trains in excess of the standard have been hauled in many cases up to 7 800 tons and the run of 125 miles to the shipping port is made at the rate of 15 miles per hour including the time for all stops On the Pennsylvania Railway a train of 105 steel wagons with 5 540 tons of coal and a gross weight including engine of 7 644 tons made a run of 127 miles in seven hours Coal trains of 4 850 to 6 150 tons gross total weight have also been hauled on this railway On the Lake Shore and Michigan Southern Railway a train of 100 steel wagons carrying iron ore and weighing 7 430 tons was hauled 65 miles at an average speed of 12 miles an hour In some cases these very heavy trains are due to special conditions such as a previous congestion of traffic at some point but it is worth noting that the standard coal train of the Virginian Railway has a gross total weight of 6 365 tons and a net load of 4 400 tons of coal

SOME PRINCIPLES OF EFFICIENCY.

CURING A SICK INDUSTRY.

BY HARRINGTON EMERSON

THE owners of a large industrial plant with many orders ahead desired to increase the output from thirteen units a month the highest average up to that time to twenty three units a month and to do this in ten months

The manager of the plant a man of unusual ability but of the old school had been in charge for some time but knew only one way to [illegible] namely to [illegible] men He th[illegible] ers for twent[illegible] of additional[illegible] ment had be[illegible] culty as it w[illegible] longer to s[illegible]

When ma[illegible] creased [illegible] ment by ma[illegible] made by two [illegible] experience, w[illegible] concluding p[illegible]

Your plant [illegible] shop erecting [illegible]

Having exa[illegible] shops and ha[illegible] superintendent[illegible] tractors and [illegible] definitely that [illegible] slight physical betterments and provided the present manager or a man of similar disposition be in authority the output of your shops can be increased 60 per cent without adding to the present forces without adding to the equipment and without increasing the payroll more than 10 per cent and that these results can be gradually attained within a period of six months

To accomplish these results certain principles of organization were advocated The organization and principles were adopted and applied by the manager and the results are shown by an extract from a letter written by the local official ten months later

New York May 1 1908

It will interest you to know that our output for the month of April showed an increase of 69 2 per cent over the monthly average of the last fiscal year

The average working hours are 9 per day instead of 10 as formerly The payroll reduction is 15 per cent amounting to $8 000 to $10 000 a month less than last year

The same efficiency engineers were subsequently called to another plant, to investigate and to advise In this case also their principles were accepted their recommendations carried into effect through modified organization with the following results

Date.	Average Number of Men.	Average Tons per Man.	Total Tonnage.	Pay Roll.	Payroll Cost per Ton.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.41	2.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5 51	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5 14	[illegible]

It is not to be supposed that two men could come from the far West go into Eastern industrial plants and through their own familiarity with the conditions know better how to direct them than the experienced local managers in charge The men who came out of the West were not as well equipped with knowledge of operation or devices were not as well acquainted with local methods and men as the local managers but they were far better equipped with knowledge of a new type of organization through which alone efficiency can be secured and they had not only this knowledge but also extended and successful experience in applying it The difference in achievement between the modern man and the man who lived thousands of years ago is not an internal difference in quality of brain but the tremendous external difference in conditions and equipment The boy with the far reaching sling knocks out the heavily armored spear wielding giant

It is exceedingly difficult to advocate certain principles without individuals tribes and nations unable to free themselves from the personal point of view immediately jumping to the conclusion that an attack being made on their competency their skill Greek athletes could have made good records if they had had bicycles motor cars and aeroplanes if they had had repeating pistols and rifles but the arrow however skilled the archer does not carry as far or as straight as the rifle bullet The principle underlying the rifle is very old that of the blow tube—a very different principle from that of the bow and string but the man who equips the savage with a rifle makes him more powerful than all the armored knights of chivalry and the man who equips the modern industrial manager with a new industrial application of an old principle of organization and accomplishment gives the mediocre manager a greater possibility of attaining high efficiency than was ever possessed even by the greatest industrial geniuses working along the old lines

The men from the West knew the new theories because they had applied them on a tremendous scale they knew how to design and operate a new kind of shop control as different from the old as the rifle is from the bow—as different as bicycle riding is from walking flying from motoring Arabic notation from Roman numerals These principles in their application to shop control may not appear particularly lofty, inspiring or even interesting to anyone except those whose pocketbooks are to be immediately benefited namely the plant owners and managers the plant workers and the clients of the plant but they will evoke deeper interest when it is perceived that they are fundamental and of universal application that in all ages lasting efficiency depended on them and without them is always impossible that the same principles have been applied elsewhere on a stupendous and noble scale and that it is not men or materials money machines and methods that count, but far more potently, theories and principles —Engineering Magazine

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The Pennsylvania Railway is now using signal instruction cars on all divisions The new cars in use on the main line are 60 feet long, divided into two compartments One room will be used for examinations, while the other will contain a table upon which is to be placed under a glass cover a large track chart of the railway which can be rolled back and forth by means of rollers placed at each end This chart shows all main running tracks switches and crossovers all signals track troughs stations and mile posts The men will be given an opportunity to study this chart prior to passing an examination on it Each car is provided with a set of model signals which can be manipulated so as to show all signal indications The cars are in charge of examiners each of whom has an assistant These men will have charge of all examinations except those on machinery and air brakes The cars will also be used for examination of employees on train rules and other subjects

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WINNERS OF THE RAND STOPE-DRILL COMPETITION

The winners of the stope drill competition in the Transvaal are announced unofficially by the South African Mining Journal to be the Holman 2¼x5 inch and the Siskol 2¼x6 inch These machines are stated to be practically tied for first place the next in order being the Chersen This competition was arranged by the government and the Chamber of Mines and was commenced February [illegible] 1909 thus the trials have been continuous for more than a year There were 21 machines entered originally of these eight failed to pass the elimination tests and the actual competition was begun by 13 types of machine Holman 2¼ Chersen Holman 2¼ Climax Imperial Murphy New Century OO Siskol Waugh Westphalia and Konomax The Climax Imperial Murphy Waugh and Westphalia were hammer drills the remainder being of the reciprocating type The essential difference between the two leading machines is stated to be that the Siskol is the faster running drill while the operating costs are considerably less in the case of the Holman 2¼ inch

Monthly statements of progress were made until August when these were discontinued At that time the relative positions of the competitors were widely different from their final standing illustrating the fact that tests of machines over short periods are not sufficient evidence on which to base a final judgment

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In a recent number of the Journal of the Society of Chemical Industry C Beadle and H P Stevens describe a machine for mechanically testing India rubber Test pieces are cut from sheets 1 millimeter thick in the form of rings 10 millimeters diameter with a 5 millimeter hole in the center and are attached to two iron hooks one fastened to a stationary block and the other to a sliding block moving horizontally on the base of the machine A cord passing over a pulley and carrying a light metal bucket is attached to the sliding block Tension is applied by running water into the vessel at the constant rate of 1 000 grammes per minute and when the test ring breaks the water supply is cut off automatically Elongation is measured by means of a pointer attached to the sliding block and moving over a scale When rupture occurs the hook falls and releases the indicator which remains at the point of total elongation

THE PROCESSES IN COTTON SPINNING II.*

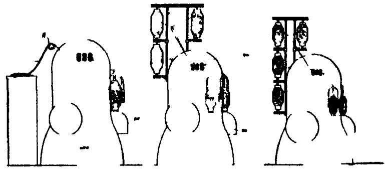
A REVIEW OF AN INTERESTING INDUSTRY.

BY LEON A HACKETT

Concluded from Supplement No 1798 page 398

FLYER FRAMES

A STAGE is reached with the completion of the carding process and also in the drawing process where the product from the machines is divided into many small lots as was shown in those processes by the use of tin cans as a means for the temporary storage of the cotton sliver In the flyer frame process where the next [illegible] these [illegible] all [illegible] of the [illegible] convenient shape for the cotton in its further handling than that of sliver in cans The form assumed by the cotton for its storage [illegible] the flyer frames according to that of a roving as it is called [illegible] and in this shape is wound onto wooden bobbins in many uniform layers like thread on a spool That it may be more clear what this change is it may be stated that there is a difference [illegible] between cotton sliver and cotton roving [illegible] the same diameter and weigh the same and this difference is in a twist which is added to the strand and being put in at the same time the roving is being wound onto the bobbins Twist in connection with cotton spinning is used for the purpose of giving strength to the strand and it does so by producing a closer interlocking or cohesion between the individual fibers while these in turn act to strengthen the strand as a whole As applied to the cotton strand the term twist denotes the number of complete turns or twists of the strand in an inch of length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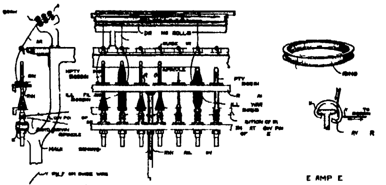

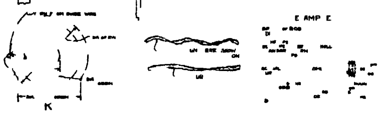

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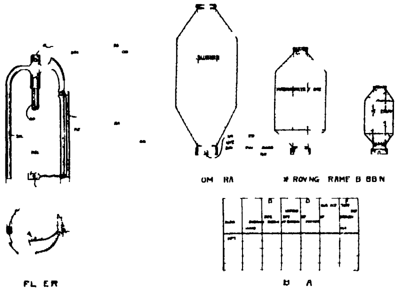
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ROVING FRAME BOBBIN

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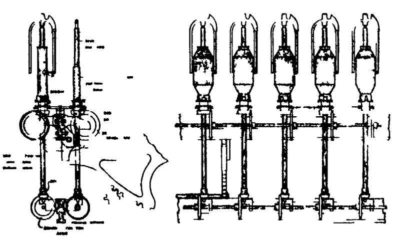
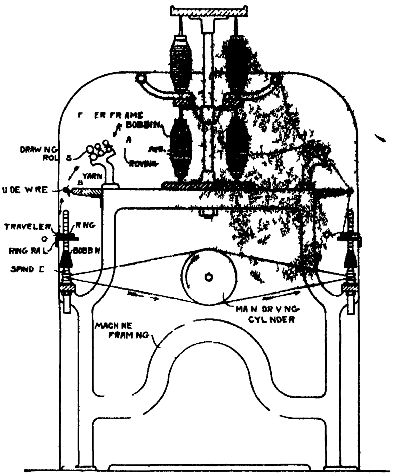


Fig 8.



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The three requirements then of this process are first the reduction of the diameter and this by means of the drawing rolls then the addition of a twist to the strand by means of a mechanism called a flyer and lastly the winding of the roving on a wooden bobbin a convenient shape for the cotton in its subsequent handling

In Fig 6 an end view of three machines used in this process is shown [illegible] first [illegible] the slubber [illegible] with stock from the last drawing process then the intermediate frame which is supplied with stock just made into bobbins on the slubber and lastly the flyer frame supplied with its stock from the intermediate frame In each of these three machines the roving is drawn down to a diameter a little finer than the preceding one while at the same time a slightly increasing number of turns of twist is put into the strand at each stage

In building a roving bobbin the principal parts of the mechanism used in direct connection with the winding are the spindle bobbin flyer presser and drawing rolls Starting with the strand of sliver from a draw frame in Fig 6 it is first passed over the bar *A* through the drawing rolls *B* then from *C* after being attenuated it passes to the top of a U shaped piece called a flyer One leg of this flyer is hollow and the roving from the top is guided down within the leg to the metal arm *D* attached at right angles to the flyer leg which is called a presser The roving after passing down the hollow leg, is wound around the presser and this in turn, as will be shown later becomes the guide for the roving as it is wound on the wooden bobbin *E* The other solid leg of the flyer is used merely as a balance to the hollow or working leg

Consider for the moment the winding arrangement for the roving while just at the point of being put on the bobbin by the flyer and the presser It is seen from Fig 8 that the spindle *A* upon which the flyer is pivoted and held fast and also the gear upon which the wooden bobbin rests held fixed to it by the projecting pin *B* are both concentric The end of the presser attached to the flyer always presses against the surface of the bobbin so that if the bobbin and the flyer were arranged with two separately driven trains of gears and driven at the same speeds and in the same direction the presser-end would under these conditions touch continuously the same spot on the bobbin during rotation With the presser-end still touching the bobbin but now however on one of greater size while it still continues at the same number of revolutions per minute its surface-speed at the end becomes increased owing to the point of contact between the bobbin and the end of the presser being farther from the center of rotation The rotation of the presser-end *D* while moving at a constant number of revolutions per minute has then its surface-speed automatically increased as the bobbin fills while the point of contact between bobbin surface and presser-end is pushed out farther from the center of rotation so also is the bobbin's surface-speed increased the same amount, with the increase of diam eter from the roving which is wound around it In order for the presser-end to effect winding, or to lap the roving around the bobbin, the surface-speed of the presser-end must always be a constant amount in excess of the surface speed of the bobbin, to equal the amount of roving to be wound on or delivered from the drawing rolls in a unit of time

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* Harvard Engineering Journal

The means by which this adjustment of speeds between presser-end and bobbin is obtained will not be dealt with here, other than to say that it is accomplished with much accuracy through the use of an epicyclic train of gears and hyperbolic cone-drums It is the principle of the winding just at the bobbin that is the important point to be gathered

In Table A, Fig 7, the approximate figures are given for a slubber bobbin five different diameters during the building having been selected

As was stated before on account of the number of small lots of cotton to be t[illegible] similar way the machines or fra[illegible] frame process are made to use the [illegible] storage for the cotton, and now the[illegible] made in multiples, as in the d[illegible] are four to six deliveries [illegible] machine

In the roving fra[illegible] multiplication is carried to a much [illegible] the multiplication runs as high [illegible] of which each spindle represents a[illegible] is saved and convenience of ope[illegible] avoidance of superfluous gearing are [illegible] arrangement, and a machine of the [illegible] illustrated in Figs 6 and 8 is what is use[illegible]

In connection [illegible] of the roving in uniform layers [illegible] in Fig 8 that the vertical position of the [illegible] flyer and presser does not change, and also that between the spindle and the bobbin there is a sleeve *C* fixed to the carriage *E* that forms the upper guide or bearing for the spindle This sleeve, so called *C* enables the bobbin to slip up and down over the spindle without touching it while the gear *F*, upon which the bobbin rests and is driven moves as a part of the carriage up and down during rotation The carriage *E* in passing through its traverse of 10 inches or more, carries with it the bobbins with all their adjacent gearing and in so doing changes the point of guiding for the roving by the presser-end to the bobbin, so that it is laid on in uniform layers

SPINNING

The final operation which converts the cotton roving from the flyer frame process into yarn is called spinning This is a process of drawing combined with an operation that puts a large amount of twist into the strand during the time when winding on a wooden bobbin takes place The drawing is required to reduce the cotton to the desired degree of fineness the twist is necessary to give the cotton some appreciable strength The strand of cotton with this large amount of twist in it is called yarn, in distinction from a roving with its slight amount of twist and though both might be of the same size and weight per yard they would be so designated In size the spinning bobbin is much smaller than the roving bobbin, and yet the length of yarn on it is probably many times greater

The single machine which is used to make this change in the condition of the cotton is called a spinning-frame, and its essential parts to be explained here are shown in Fig 10. The first of these is the spindle, which is a rod of steel so fashioned after many modifications leading up to its present form that it is enabled to be revolved at the high speed of 10,000 revolutions per minute or more, on account largely of a self-contained and self lubricating bearing The spindle bearing is fixed in its position on the spinning-frame by the nut *E* (Fig 9), and is exactly concentric with the ring *F*

This ring is shown separately at *G* It performs a most important part in the operation of spinning Its section, it will be noticed is nearly that of an I beam and over the upper flange during spinning a spring loop of wire or a clip called a traveler is snapped that it may run around freely thereon

This traveler is again shown at *H* on an enlarged scale While swinging around on the ring it is the means of winding and twisting the yarn as it goes to the bobbin The bottom flange of the ring is snapped in between little clamps attached to the ring rail so that the ring is held fast to it and as before is exactly concentric with the spindle

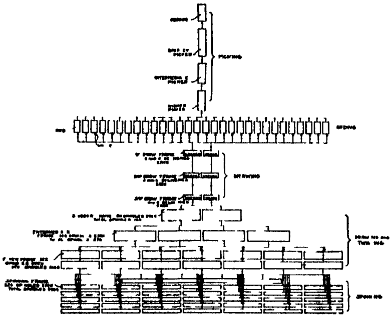


Fig 11

By means of a ring rail lifting rod *I* and a cam motion the position of this rail, containing a number of rings varying from 75 to 150 is alternately changed slowly up and down through a traverse of 6 or 7 inches

Returning now to the operation of the stock through the machine we shall see as in the case of the intermediate and flyer frames that the cotton while in process of treatment was held on bobbins resting in racks or creels and this is similarly the method used for holding the cotton in the spinning process From the flyer frame bobbin then which rests in the creel or rack of the spinning frame the cotton unwinds and is drawn in at the drawing rolls *A* Fig 10 Accelerated surface speeds of these rolls attenuate the roving to the required fineness of diameter and then the strand passes from the rolls through the guide wire *B* to the metal clip or traveler *C* then finally is wound on the wooden bobbin At the point where the cotton is twisted and in the action of being wound round the bobbin after leaving the guide wire the spinning frame operation has its difficult part to see

In Fig 9, at *K* on a larger scale, the winding and twisting arrangement is more clearly brought out The winding operation under certain special conditions will show better the principle involved than under normal conditions of running Consider first the traveler to remain stationary on the ring then the yarn fed through it to the bobbin would be wound on the bobbin at a rate equal to the surface-speed of the bobbin This for a bare bobbin of the diameter of ½ inch and a spindle-speed of 9 000 revolutions per minute would be nearly 14,150 inches in a minute The drawing-rolls *A* deliver, however, only about 900 inches in that time, which it is proposed will be wound on the bobbin at the same time The relation in speeds that meets this large difference in surface-speeds is obtained by allowing the traveler partially to catch up with the spindle or bobbin rotation by swinging round on the ring meanwhile paying out yarn through the traveler to the bobbin

Again take the case of operation when the bobbin and traveler move at the same turns per minute then there is no winding at all and instead it is entirely twist that would be put into the yarn Between these two extremes a speed for the traveler is found that admits of the necessary winding action to take up the yarn delivered by the drawing rolls and the balance of the revolutions is utilized in putting twist into the yarn The selection of a properly weighted traveler gives this relation in speeds to a nicety so that the traveler has just sufficient weight to cause it to drag on the ring an amount that would be equivalent in surface speed to the length of yarn delivered from the drawing rolls in a minute while the rest of the speed goes into putting twist into the yarn

The whole winding scheme by the traveler is virtually the same as the winding on a flyer frame except that in the latter case the corresponding amount of lapping of the roving about the bobbin by the flyer, and the turns of twist put into the roving are determined mechanically and positively while in spinning the winding and the twist are automatically put in together by the traveler and without that same precision

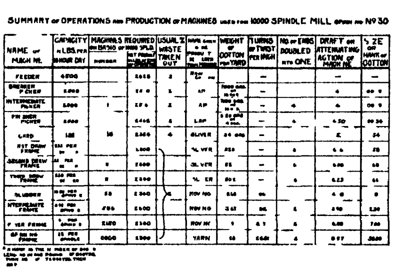
Reference to Fig 9 shows why it is that the traveler is forced to turn on the ring at all The pull of the yarn at the bobbin during winding can be divided into two forces one of which acts along line *BD* and is ineffective except to pull the traveler toward the center *O* and thereby cause friction between the ring and the traveler The other force *AB* (or *CD* when the bobbin is empty) acts tangentially to the ring or the bobbin and is the one that really causes the rotation of the traveler on the ring

Now while the yarn is being fed through the traveler to the bobbin and swings round on the ring the ring being fastened to the ring rail which moves up and down causes the point where the yarn is guided to the bobbin by the traveler to change continually and so the yarn is laid on in uniform layers

Spinning frames like roving frames operate in multiple form that is a large number of lots of cotton are drawn twisted and wound on bobbins at the same time to save the unnecessary duplicating of parts

The foregoing explanation has embodied the essentials in the various processes of cotton spinning of interest to the average reader and a summary in diagram form together with the numerical relations given in Table B shows additional points perhaps not appreciated before

Fig 11 indicates by the arrows the passage of the stock from one process and one machine to another on the basis of figures in Table B and shows especially the increasing multiplication of the machines necessary to take care of the product at each stage as the capacity of each unit grows smaller The figures also, in Table B are applicable only to a mill running on yarn of a particular size namely 30's though the production and particulars of a yarn of any other size would be similar in many respects



SUMMARY OF OPERATIONS AND PRODUCTION OF MACHINES USED FOR 10000 SPINDLE MILL SPUN NO Nº 30

NAME OF MACH NE	CAPACITY IN LBS PER 10 HOUR DAY	MACHINES REQUIRED ON BASIS OF 1000 SPLD.		USUAL % WASTE TAKEN OUT	NAME [illegible] PRODUCT [illegible]	WEIGHT OF COTTON PER YARD	TURNS OF TWIST PER INCH	NO OF ENDS DOUBLED INTO ONE	DRAFT OR ATTENUATING ACTION OF MACH NE	SIZE OR HANK OF COTTON
		NUMBER	[illegible]							
FEEDER	4500		[illegible]	2	Raw Co[illegible]		—		—	—
BREAKER PICKER	[illegible]		[illegible]	[illegible]	LAP	[illegible]	—		4	[illegible]
INTERMEDIATE PICKER	[illegible]	1	[illegible]	2	LAP	[illegible]	—	4	4	[illegible]
FINISHER PICKER	[illegible]		[illegible]	[illegible]	LAP	[illegible]	—	4	4.50	[illegible]
CARD	[illegible]	[illegible]	[illegible]	4	SLIVER	[illegible]	—		[illegible]	[illegible]
1ST DRAW FRAME	[illegible]		[illegible]		SLIVER	[illegible]	—	[illegible]	[illegible]	[illegible]
SECOND DRAW FRAME	[illegible]	[illegible]	[illegible]		SLIVER	[illegible]	—	[illegible]	[illegible]	[illegible]
THIRD DRAW FRAME	[illegible]	[illegible]	[illegible]		SLIVER	[illegible]	—	[illegible]	[illegible]	[illegible]
SLUBBER	[illegible]	[illegible]	[illegible]	[illegible]	ROV NO	[illegible]	[illegible]		[illegible]	[illegible]
INTERMEDIATE FRAME	[illegible]	[illegible]	[illegible]		ROV NO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FLYER FRAME	[illegible]	[illegible]	[illegible]		ROV NO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SPINNING FRAME	[illegible]	[illegible]	[illegible]		YARN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE B

Fig 12

Elastic Copal Varnish.—1 part camphor 4 parts copal 12 parts ether The solution only becomes perfectly clear after standing for a long time it should be allowed to stand in bottles for weeks and then the clear supernatant fluid passed off At the bottom we have only softened copal which must be again treated with ½ to ¾ part camphor 2 parts of copal and 12 parts of ether.

LORD KELVIN.*

HIS WORK IN TELEGRAPHY AND NAVIGATION.

BY PROF. J. A. EWING.

LORD KELVIN'S work was great and many sided. We might compare it to the cathedral in some crowded mediæval city where no place can be found commanding a general view. You approach by one narrow street or another seeing from each only some portion of a particular face of the building. The lecturer might take up the mathematical work of Kelvin in the theory of electrostatics in the theory of magnetism in the theory of elasticity in hydrodynamics in the wave theory of light his contributions to thermodynamics, which included the establishment of an absolute scale of temperature and the enunciation of the principle of the dissipation of energy his experimental work on the electrodynamic quality of metals his speculations on the structure of matter his views on the age of the earth his share in fixing the electrical units or on the more practical side his electrical measuring instruments from the electrometers of the early days to the ampere balances and wattmeters which he designed when the need for such instruments became apparent with the growth of electrical engineering. Any one of these subjects or others that might be named would provide a more than ample text. To night I have selected two portions of Lord Kelvin's work as the most suitable to bring before you namely his work in submarine telegraphy and in navigation. Both of these are practical matters which appeal to members of this institution. They illustrate well the bent of his genius as an engineer. In both of them he made inventions of first rate importance inventions which not only met an immediate requirement but have stood the test of time and an additional reason for the selection is the personal one that both in telegraphy and navigation it was my good fortune as one of his young assistants to see some of his inventions in the making.

His connection with telegraphy had begun long before when he was only thirty years of age. It dates from 1851 and to appreciate rightly the part he began to play then I must ask you to go back as far as 1850 the year of the earliest submarine telegraph. It was in August 1850 that a line consisting of a single copper wire insulated by gutta percha wound on a great reel on the deck of a steam tug in Dover Harbor was laid from Dover to Calais. There was no sheathing or protection of any sort the line was what we should now call a bare core and so light was it that lead sinkers were attached at every hundred yards to insure its going to the bottom. In a few hours it was cut by the anchor of a fisherman who took home a piece to show to his family as a curious new kind of seaweed but during its brief life it gave the operators much food for thought. Accustomed only to the clear sharp signals of land lines they could make nothing of those got from the cable and Mr Willoughby Smith tells us how at each end of the line it was regretfully concluded that the operator at the other end must have been lunching not wisely but too well. This was the earliest experience of the effects of electrostatic induction in retarding the signals and altering their character. The cable is equivalent to an extended Leyden jar of large capacity and at every application of the sending battery there is a gradual charging up so that the signal current which arrives at the distant end does not at once reach its full strength and further when the contact with the sending battery stops the current does not at once cease but tails off slowly as the cable discharges the electricity it has accumulated. The current accordingly arrives in the character of a wave slowly rising to a maximum value and then slowly subsiding each time a signal is sent.

In a short cable this causes little trouble it only makes the process of signaling a little slower but the instruments which serve on land lines may still be used. A successful Dover Calais cable properly covered with a protecting sheath was laid in 1851 and was soon followed by other short lines. The general character of the electrostatic charge in a cable was explained by Faraday and it was experimented on by Latimer Clark in a cable 110 miles long laid to connect England with Holland but no one knew then in what manner the retardation of signals to which it gives rise depended on the electrical characteristics or how it would be affected in cables of different lengths or with different dimensions of core. It was in 1854 that Thomson's attention was directed to the subject by Stokes following on a conversation at the British Association and in this way began the connection with submarine telegraphy which was to prove of momentous import.

Thomson attacked the problem with characteristic ardor and in less than twelve days he sent a complete solution to Stokes which was published in fuller form in the Proceedings of the Royal Society for May 1855. In this paper he points out that the effect of electrostatic induction is to make the flow of electricity in a cable correspond to the flow of heat in a solid conductor as investigated mathematically by Fourier. He formulates the equations and draws what is called the *curve of arrival* the curve namely which shows in what manner the current gradually reaches its full value at the distant end of the cable when contact with the battery is made at the sending end. He shows how the current falls away when the battery is removed and the cable is put to earth, and how in cables of different lengths but of the same dimensions of core the time taken by the current to reach any particular fraction of the full value will vary as the square of the length.

This result of the theory was of fundamental importance. It was also at the time of particular interest for the project was then beginning to be mooted of connecting England and America by wire. The only experience available as to speed of signaling was on short cables and in passing from them to a line 2,000 miles long the law of squares, as it was called seemed at first to give little prospect that signaling across the Atlantic could be accomplished at a speed that would be commercially practicable.

To lay the cable it was coiled on board two ships of war the British battleship Agamemnon and the United States frigate Niagara. On August 5th 1857 the shore end was landed at Valencia and the Niagara began to pay out the intention being that her section should be laid first and the Agamemnon should continue the work after making a splice in mid ocean but the paying-out gear was very crude the brake for maintaining a proper tension in the cable was difficult to regulate and after 300 miles were laid there was a mishap at the brake and the cable parted in 2,000 fathoms. The ships returned to Devonport the cable was stored for the winter new machinery was designed and some 700 miles of fresh cable were manufactured against the next attempt to be made in the following year.

Thomson had joined the expedition at the request of his brother directors and was on board the Agamemnon. He came back full of ideas as to both the electrical and the mechanical sides of the great problem. On the mechanical side he had worked out, for the first time the theory of the forces concerned in the laying and lifting of deep sea cables this was published almost immediately after his return. Let me give you a brief sketch of the results of this theory.

A cable paid out from a ship going at uniform speed does not hang as a catenary but takes the form as it sinks of a straight line stretching at a uniform slope from the ship's wake to the point far in the rear at which it touches the bottom. This is because each part of the cable in sinking through the water attains almost immediately a constant velocity of descent against the resistance which the water opposes to its motion. Imagine a ball heavier than water to be dropped from a ship. It will after sinking a foot or two attain a practically uniform velocity and keep that until it reaches the bottom. Imagine now a ship to drop a series of such balls at regular intervals while she steams ahead at a steady speed. At any instant the depth through which each ball has sunk will be proportional to the time which has passed since it was dropped and therefore to the distance run by the ship and hence a line joining the successive balls will be a line of uniform slope. The continuous cable behaves in this respect like the row of balls but with this important difference. Each ball sinks vertically it has no tendency to do anything else, but the cable tends not only to sink, but to glide along the direction of its own length, just as a rope resting on an inclined plane tends to glide down it. A certain amount of such gliding is desirable indeed necessary for it secures that the cable will be laid with a sufficient percentage of slack to accommodate itself to any inequalities on the bottom, and to provide for the possibility of its being raised should that be required. It is the function of the paying-out brake to apply just so much retarding force as will allow the right amount of this gliding to take place, and not too much. As cables are actually laid there may be 10 or 12 per cent of slack, and this means a considerable velocity of gliding motion. In a cable of the type which was afterward successfully laid across the Atlantic, the straight line had a slope of about 1 in 8½— in other words with a depth of two miles there were seventeen miles from the ship to the place where it touched bottom. On the gliding motion down this long slope the frictional resistance of the water is an important factor it reduces very much the retarding force needed at the brake. If it were simply a question of holding the cable from gliding down the slope at all, the retarding force would be equal to the weight in water, of a length of cable equal to the depth. In fact however, it is about half that the other half being accounted for by the frictional resistance the cable experiences in gliding down the slope.

In the early summer of 1858 the cable squadron was again ready to put to sea. New paying-out brakes had been devised. Thomson had succeeded with much difficulty in getting systematic tests of the conductivity established during the manufacture of the additional 700 miles. Most important of all he had invented a new signaling and testing instrument which was to make Atlantic telegraphy commercially practicable. This was the mirror galvanometer the first description of which is found in his patent of 1858.

We have no time to linger over the story of the cable of 1858. This time the two ships after encountering a storm of great severity in which the coiled cable suffered severe damage met in mid ocean spliced the cable and began to pay out simultaneously the Agamemnon steaming toward Ireland and the Niagara [illegible] Newfoundland. The cable broke when [illegible] were paid out. Again the ships met [illegible] splice and again the cable failed when [illegible] had run out. A third [illegible] some 200 miles were laid when [illegible] this time at a place where it [illegible] The ships returned to [illegible] Thomson, and the other [illegible] not discouraged advised the board [illegible] attempt. Their advice was taken [illegible] met at the mid-ocean rende[illegible]cess crowned their efforts. On Au[illegible] completed their task, and the ends [illegible] brought to land.

Scarcely had the [illegible]d by this great event began to subside [illegible] apparent that all was not well. The [illegible] cable had been handed over to Mr W[illegible] who attempted with little or no success to establish communication by means of his own signaling instruments. It was only when the galvanometer of Thomson was resorted to with a simple Daniell battery to send the current, that messages were transmitted. The board dissatisfied with Whitehouse's action, directed Thomson to take complete charge. Various important messages passed but the tests showed that the insulation of the cable had broken down, a bad fault developed which had doubtless been intensified, if not produced, by the high tension induction coils used by Whitehouse. The signals grew more and more feeble and in a few weeks the cable altogether ceased to speak.

It never spoke again and not until 1865 was the attempt made to lay a new Atlantic cable. By that time much had been accomplished. It was in the intervening years that the work of establishing standards for electrical measurement was undertaken by a committee of the British Association. The committee was appointed at the instance of Thomson, and he took a prominent part in its work. Besides this the cable engineers were busy and were gaining experience from lines laid in other places. Methods of systematic testing were devised, a type of cable was designed which was better adapted than before to bear the strain of laying, and especially the much severer strain of picking up, and material improvements were made in the paying-out machinery.

In 1865 the 'Great Eastern' was available for laying the cable. Thomson, along with Cromwell Varley, went as a consulting expert on behalf of the company. Twelve hundred miles were successfully laid, and then a fault showed itself, picking up was begun, but in maneuvering the ship the cable parted in deep water. Attempts were made to recover it by grappling, three times it was hooked and brought part of the way to the surface, but the shackles used to couple up successive lengths of the grappling rope were too weak to stand the strain. Grapnels were and cable were lost, and the ship returned with the task unfinished, but with everyone now full of confidence, not only that a sound cable could be laid, but that the lost cable could be found and lifted

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* From the second Kelvin lecture delivered at the Institution of Electrical Engineers

In 1866 the thing was done, an entirely new cable was laid with complete success, and then the "Great Eastern" with her consorts proceeded to the lost end of the cable of 1865, and began once more to fish in water more than 2,000 fathoms deep A fortnight passed before the watchers at Valencia saw any sign, then the spot of light began to flicker, and presently the flickerings shaped themselves into letters and words The cable had awakened to life A few days more and it too was complete

Throughout the operations Thomson was in the ship, Varley remained at Valencia Thanks to their labors, and to those of Mr Willoughby Smith the contractors' electrician, the appliances for testing on board ship had been brought to a degree of perfection that left nothing to be desired By this time it was generally recognized that the credit for Atlantic telegraphy, regarded as an electrical achievement, belonged to Thomson though in his characteristic manner he would, when speaking of the subject dwell on the parts played by others. Along with Mr Canning the engineer of the expedition, and Captain Anderson, who commanded the Great Eastern, he received the honor of knighthood

For a time his mirror galvanometer remained the only instrument by which conversation could be carried on He now proceeded to design a substitute for it which should give a record of the successive electric impulses instead of merely exhibiting them to the watchful eye of a skilled clerk To secure greater power in the movement of the indicator he inverted the function of magnet and coil, making the coil the movable piece and the magnet the fixed piece The coil was therefore made very light, the magnet which being stationary might now be very heavy was made exceedingly strong and was arranged so that the coil lay in an intense field between its poles The movement of the coil actuated a very light pointer or rather pen in the form of a siphon shaped tube of fine drawn glass from which ink was deposited on a running paper band Here we find the earliest example of the moving coil type of galvanometer often called the D Arsonval type by those who do not recognize its real origin

It is a type now familiar in many practical instruments for the measurement of direct current amperes and volts, but an important element in the invention is still to be named It was essential that the glass pen should write without friction and Thomson effected this by the happy device of electrifying the ink so that the ink and the paper attracted one another with the result that the siphon was maintained in a constant state of rapid vibration alternately advancing to the paper to deposit a minute drop of ink and then springing back but all the time free to follow, without friction the movements of the coil in obedience to the electric impulses arriving through the cable Dynamically the siphon recorder has to satisfy the same conditions as those that determined the design of the mirror galvanometer It draws on the moving strip of paper a curve of arrival for every one of the successive currents of which the signals are composed

To this day the recorder remains in universal use as the standard instrument in submarine telegraphy It has been simplified by the substitution of permanent field magnets for electromagnets and by the use of an electromagnetic vibrator for the siphon instead of electrification changes which were made in later years by Thomson himself

(To be concluded)

LIGHTNING.

A SUMMARY OF RECENT STUDIES.

BY PROF. ELLERY B. PAINE, M. S., E. E., UNIVERSITY OF ILLINOIS

A CENTURY and a half ago when Franklin made his famous kite experiment it was generally believed that lightning was the explosion of vapors which collected in the atmosphere under certain conditions Franklin's proof that lightning is electrical in its nature stopped much speculation over the chemical composition of those vapors and the way in which they became ignited to produce the lightning explosions. Since Franklin's time scientists have considered lightning similar to the sparks of experimental electrical apparatus except that the lightning is on a vastly [illegible]

During the last hun[illegible] to learn the secret of [illegible] hypothes[illegible] electric [illegible] evaporati[illegible] against the [illegible] fication We [illegible] derstand [illegible]

Many w[illegible] just have classified lightning [illegible] zigzag, sheet and ball lightning [illegible] sheet lightning is unlike the first named form only in having the direct light from the flash hidden from the eye In this form of lightning one sees the light reflected from the clouds Many marvelous accounts of the slowly moving ball lightning have been recorded Modern scientists who had never seen this form of lightning were inclined to be skeptical. The discovery by Prof Righi of Bologna[1] of a method of producing such discharges experimentally leaves us little ground for doubting the existence of ball or globular lightning

Dove was perhaps the first to attempt to measure the time taken for a lightning stroke[2] He used a rapidly revolving disk marked with colored sectors He discovered that lightning discharges are usually made up of several component flashes His experiments showed that each separate flash was apparently instantaneous Four years ago Schmidt made a similar investigation[3] and found that the separate flashes were completed in less than 1-30000 second

In recent years the camera has been of much value in lightning study The first work done in photographing lightning appears to have been that of Prof Keyser at Bonn[4] Photographs of lightning taken with stationary cameras sometimes showed the discharge separated into its component flashes by the side drift of the air currents This suggested to Prof Weber of Kiel the use of a revolving camera which would allow the impressions of the various discharges to be still more widely separated on the photographic plate[5] Later Dr Walter of Hamburg developed and used a rotating camera.[6] Similar work has been done in the United States by Larson[7]

The camera investigations have shown that lightning strokes are usually composed of not less than five or six discharges along nearly the same path Some strokes are made up of as many as forty flashes. The time required for complete discharge sometimes is as great as 0 6 second

In 1858 Feddersen found proof of the oscillatory nature of Leyden jar discharges It is thought that lightning discharges also are oscillatory but no direct proof has ever been made Experiments made to solve this problem have not been conclusive[8]

Estimates of the voltage necessary for lightning based on data obtained from such discharges as may be produced in the laboratory lead to values which appear unreasonably large Lodge estimates the potential difference required for a lightning stroke one mile long as 5 000 million volts[9] Steinmetz calls attention to the fact that with such a potential difference as this the corona effect would be very marked It is probable that long strokes may take place with voltages far smaller than the estimate quoted It is known that a dielectric breaks down at a point where the potential gradient at that place is too great That is a dielectric cannot withstand an electric stress greater than that caused by a certain number of volts per inch The exact value of the limiting potential gradient varies with the character of the dielectric If in the atmosphere we have even for a short distance a too great potential gradient discharge will take place Because of the lowering of the potential at one end of the discharge path the potential gradient may become too great at that point so that the discharge extends over another space In this way it appears reasonable that a long discharge may result although the initial difference of potential is sufficient to cause discharge over only a much shorter path This explains how a stroke of lightning may occur wholly within a single cloud It was formerly thought that lightning occurred only between two clouds or between cloud and earth

Hence we see that the condition needed for lightning discharge is that the potential gradient along a path through the atmosphere be greater than the air can withstand

It has been found that under normal conditions the potential gradient along a vertical line from the earth's surface is several hundred volts per foot As stated before we are not certain what causes this change of potential at different elevations Particles of water formed by condensation of moisture in the atmosphere will have potentials equal to that of the air at the place of formation As numbers of these small particles combine into larger drops the potential of the drop increases with increase of size, because the capacity of the drop increases only as the radius, while the total quantity of electricity increases as the mass or the third power of the radius Hence great condensation will cause the potential of the drops of water to become greater than the potential of drops at a point of less condensation If we have within a cloud quite unequal condensation at various points we may have potential gradients so great that the air along certain paths is broken down. We have these conditions most frequently in the case of the gusty clouds formed near the earth on hot summer days.

The great heating effect of lightning indicates that its current strength is high Dr Pockels has investigated the strength of current in lightning rods which had been struck by lightning The tests reported indicate currents of ten thousand amperes or more

The total energy of a single flash of lightning has been estimated by Steinmetz as 10 000 kilowatt seconds This estimate is based on the energy required to produce illumination equal to that given during a lightning stroke

Lodge arrives at about the same result from the calculation of the amount of energy stored in a certain volume of air due to the maximum electric tension air is able to withstand

Our knowledge of lightning is far from complete The loss of life and property each year because of lightning is large In the United States alone the loss according to government records amounts to several hundred lives and between one and two million dollars worth of property One of the great problems of the electrical engineer is the protection of electrical apparatus from lightning troubles This problem has assumed greater proportions since the use of long distance high potential transmission lines A better understanding of lightning is much to be desired The Technograph published by the Engineering Societies of the University of Illinois

THE ELASTICITY OF TIMBER

Numerous experiments have been made in Europe America and Australia for the purpose says The Builder, of obtaining reliable data as to the physical properties of timber employed in building and architectural construction Nevertheless few records are available enabling designers to take into account the coefficient of elasticity in a direction perpendicular to the fibers A series of tests conducted by Signor Panetti in the laboratory of the Naval College at Genoa bring out clearly the difference between the coefficient of elasticity of timber when tested parallel to the fibers and the value obtaining when the material is tested perpendicularly to the fibers The tests were conducted on prisms of Piedmontese oak 2¾ inches square some with the fibers parallel to the length of 78 inches and others with the fibers perpendicular to the length of 39 inches Those of the first kind were subjected to compressive stress gradually increased up to 4,770 pounds per square inch with the result that the coefficient of elasticity was found to range from 1,720 000 pounds per square inch for stresses within ordinary working limits down to 1 250 000 for the stress at the elastic limit Prisms of the second kind were subjected to much smaller pressures and it is stated that the corresponding deformations showed the maximum value of the elastic coefficient to be not greater than 117,000 pounds per square inch Judged by these results the compressibility of timber across the grain is about fifteen times its compressibility with the grain It should also be noted that the elastic limit is approximately marked by a stress equal to one-fifth that at the elastic limit of timber tested with the grain

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[1] Electrical Review, London, April 3, 1896

[2] Poggendorff Annalen, 1868, S. 271

[3] Elektrotechnische Zeitschrift Sept 28, 1905.

[4] Wiedemann Annalen, 1889, P 121

[5] [illegible] 1889 P. 781

[6] Physikalische Zeitschrift 5, S. 168.

[7] Annual Report Smithsonian Institution, 1905.

[8] Physikalische Zeitschrift 2 P 715

[9] Lightning Conductors and Lightning Guards. Page 9.

[10] Wiedemann's Annalen 65 S 458

[11] National Electric Light Association. 1907 v 1 P 461

OIL FIELD PHENOMENA.*

THE OCCURRENCE AND RECOVERY OF PETROLEUM.

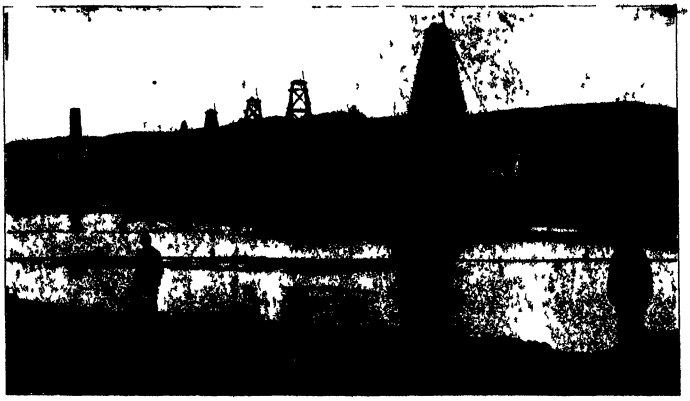
BY A. BEEBY THOMPSON, A.M.I., MECH. E., F.G.S.

In few directions are there greater inducements for young enterprising engineers than in petroleum mining which during recent years has advanced with such rapid strides that oil producers everywhere feel the need for trained engineers capable of occupying the many positions of trust which naturally arise

The oil industry is still in its infancy although so much has been done during the last few years in developing new regions in all parts of the earth and for many years enterprises which often pay such phenomenal returns upon capital must prove an attractive source of investment A brief review of the mode of occurrence of petroleum and the means adopted in its search and recovery may be the best manner of eliciting interest in a subject which is daily assuming greater importance in the world's progress and in which the need for specially trained engineers is annually being more felt

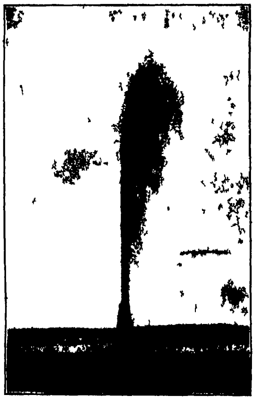
Petroleum is a liquid composed of a mixture of a great number of hydrocarbons Rarely are two samples of petroleum from different districts composed of the same hydrocarbons and even in neighboring wells the product is often very dissimilar The exact composition of petroleum is difficult to determine as when subjected to heat the constituent hydrocarbons break up into other members of the series or become converted into entirely different series of hydrocarbons Even when exposed to atmospheric influences petroleum undergoes changes through evaporation and oxidation The subject of the constitution of petroleum is however much too large to discuss in a brief article

Porous strata in certain localities on the earth are charged with petroleum and where they outcrop or even closely approach the surface a steady exudation of oil has often led to the formation of beds of asphalt as a result of evaporation and oxidation It is such indications which have often attracted the attention of prospectors and led to drilling of wells for oil In other cases the occurrence of strata charged with petroleum far below the surface is indicated by issues of inflammable gas in the vicinity of sharply inflected beds which have been fissured sufficiently to allow the gas and oil contained in their pores to escape At other times where the inclined petroliferous beds outcrop there is nothing further to betray the petroliferous character of strata than a brown discoloration of occasional porous bands which discoloration is frequently concealed by a bleaching action and which would mislead any casual observer



RUSSIAN FLOWING WELLS

Some of the above phenomena surrounding the occurrence of petroleum are often to be seen on an extensive scale where highly productive oil strata reach or closely approach the surface under suitable conditions Petroleum when present in large quantities is always accompanied by great quantities of dissolved gaseous hydrocarbons consequently its subterranean distribution differs from all other minerals and water and its movements are largely influenced by structural features which the containing beds assume Where sedimentary strata containing petroleum and gas have been thrust into folds as a result of earth movements a steady separation and redistribution of the containing fluid has often occurred and led to the segregation of great volumes of oil and gas in favored localities



RUSSIAN FLOWING WELL

One of the usual structures imparted to strata by terrestrial crushing forces is an anticline and syncline and where such conditions characterize beds in which petroleum has been secreted and suitable impervious cappings exist the oil and gas has steadily mounted to the summit of the anticlines while any water present in the series has largely accumulated in the synclines thereby often displacing oil and forcing it into the anticlines The process of segregation has doubtless been slow and in many cases the great accumulations of oil probably attained their existing location long before the formations reached the present severe inclination they often partake and before faults and disturbances isolated sections of strata

Many of the anticlines in which great volumes of oil are stored are exceedingly sharp inflections with sides that sometimes reach a nearly vertical inclination and in such cases the beds have been usually so much fractured that petroleum and gas found their way from the true oil horizon to sedimentary strata of a newer age above and impregnated porous beds which were formerly barren Such secondary deposits of petroleum are not uncommon and they often yield remunerative productions of oil and gas when perforated by drilling

The ideal structure of a regular anticline with gently sloping sides beds little fractured and disturbed and suitable impervious covering of clays or shales is rarely found but where less perfect structures exist enormous volumes of gas and oil have accumulated and can be reached by drilling In the majority of cases surface disintegration has proceeded so far since the present form was imparted to the beds that the summits of the anticlines have long disappeared leaving outcropping productive strata on the surface Under such circumstances it might be argued that the oil should have all escaped from the beds if such subterranean movements as those described are in progress but several forces are operative in preventing this In the first place the strata have usually been faulted since the interchange of oil and water preventing thereby the continuity of a single stratum over a large area secondly the water which was often the transporting agent during the process of interchange has largely departed or sunk into the synclinals and thirdly the oxidation of petroleum in the vicinity of the outcropping oil beds has often led to the production of an impervious residue (like asphalt) which acts as a partial seal to the further escape of the contained fluids

There is however ample demonstration that there are movements of oil and gas still proceeding where oil bearing strata are inclined or fractured and further, the effect of earth movements on the subterranean distribution [illegible] has often been observed In the [illegible] are nowhere displayed [illegible] are in some other countries [illegible] considerable deposits of oil [illegible] of great volumes [illegible] in Russia Burma [illegible] that the greatest exhibits of [illegible] may be seen

Around the Baku oil [illegible] hills of asphalt are to be seen, and the con[illegible] of the heavy fluid may be watched in many localities. At certain spots volumes of gas steadily emerge from cracks in the surface, and where the beds are only covered by an inconsiderable depth of damp clay, the escaping gas produces a puddled mass which has been ejected until hills several hundred feet in height have been formed The activity is still maintained and periodically when an unusually long period of quiescence has preceded and the gas has acquired a high pressure tens of thousands of tons of clay are ejected in a few hours and many acres of land covered

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* Yale Scientific Monthly

At other points where no moist clay covers the beds great outbursts of gas, sometimes accompanied by oil, occur, and numerous holes sufficiently large to admit the body of a man are opened In the West and East Indies much the same conditions exist and for miles in the tropical jungles along the crests of anticlines may be observed both heavy oil and gas steadily issuing from the earth forming cones of asphalt mixed with earthy matter with which it is usually associated

MUD VOLCANO NEAR VARSNIKOVSKAR IN THE TAMAN PENINSULA SOUTH RUSSIA

Exceptional activity is usually displayed during earthquakes in such localities At the great earthquake of Schemakha in the Caucasus in 1902 inflammable gases emerged from fissures in the earth and becoming ignited greatly added to the terror of the situation and in the Arakan Island off the coast of Burma the mud volcanoes usually develop great activity at periods of seismic disturbances

Similar eruptions occur beneath the sea where inclined oil bearing str [illegible] in the Caspian Sea there [illegible] volumes of escaping gas [illegible] that small boats have be [illegible] Peninsula of Borneo [illegible] urma and in the Caspian [illegible] matter has been ejected at [illegible] form islands on which a la [illegible] ted but in such cases the [illegible] ad ually washed away [illegible] of soft puddled clay whi [illegible] e action of waves

The Pitch Lake of [illegible] what nature can perform [illegible] Within a basin, with [illegible] created by the disintegr [illegible] agency of escaping gas a [illegible] tons of an emulsified pr [illegible] water and siliceous matter has been produced from oil escaping from inclined oil bearing strata To-day wells sunk close to the lake are yielding large supplies of oil demonstrating if such proof were necessary the origin of the asphalt

The above very incomplete outline of some of the phenomena associated with the occurrence of oil will convey an idea of the interest in which such a subject is shrouded and the phenomena connected with the extraction of petroleum are no less interesting

Petroleum in commercial quantities is almost exclusively restricted to sedimentary strata and is principally confined to sands stratified with clays or shales in certain horizons In order to penetrate the productive zone at a depth sufficiently removed from the surface or outcrops to obtain remunerative supplies of oil a considerable depth of unproductive sedimentary strata has usually to be pierced before the oil beds are reached In some cases the thickness of strata within which oil is found at intervals reaches several thousand feet wherein most porous beds prove productive but usually the oil is strictly confined to certain definite horizons which can only be ascertained by trial

Some of the Eastern oils of América are obtained from beds of dolomite but most of the petroleum of the world is drawn from sands and sandstones of varying quality distributed amid argillaceous shales.

Oil wells are to-day almost exclusively drilled, the process in use depending upon local conditions In Roumania alone are wells still dug by hand often to a depth of 400 feet by men skilled by many years of practice in this particular and dangerous work. In the design of machinery and tools to drill to depths of 1,000 to 3,000 feet great ingenuity and skill has been directed, and each year improved plant enables quicker progress to be made In many fields where the strata are reasonably compact and not excessively hard from 40 to 100 feet per 24 hours can be penetrated with 8 inch to 10 inch tools, whereas in less favorable strata the rate of progress may not exceed an average of 5 to 10 feet daily

Water sources have sometimes to be excluded before the productive oil beds have been reached as neglect to take this precaution often results in ruined wells through the flooding of the oil stratum Operations for the exclusion of water are generally expensive and difficult especially where there is a paucity of thick impervious beds above the oil source into which the lining tubes can be firmly driven

The cost of drilling oil wells varies greatly In the Petrolea oil fields of Ontario Canada where most of the wells only reach a maximum of 500 feet the cost does not exceed $500 In Pennsylvania and the Eastern oil field of the United States the cost may not exceed $5 000 for wells 2 000 feet deep as also in parts of California but in other Californian oil fields where drilling is more difficult and in Roumania and Galicia wells 2 000 to 3 000 feet deep often entail an expenditure of from $25 000 to $30 000 In the Baku oil fields of Russia where exceptional difficulties are encountered wells of 2 000 to 2 700 feet usually cost from $40 000 to $50 000 and take from 12 to 18 months to complete

The penetration of an oil source is generally indicated by an escape of gas and an influx of oil into the well Where water is present in the hole the existence of oil may be concealed and some experience is necessary to decide whether an oil source has been entered In some cases the striking of a virgin oil source leads to such a violent expulsion of oil gas and earthy matter that the drilling tools are blown from the borehole and the derrick shattered Occasionally gas alone is expelled at a pressure which defies all measures undertaken for its control and for weeks months and even years wells in Borneo have been left discharging gas at the rate of many million cubic feet daily before they could be returned to and carried to the oil sources beneath.

Sometimes the oil is contained in hard rock which will not deliver up its contents until it is shattered by blasting with a high explosive

The most wonderful discharges of oil and gas were witnessed in the early days of the Baku oil fields where individual wells have in the course of a few months yielded more petroleum than tens of thousands of wells located in less prolific territory

In the year 1898 one well in Bibi Eibat Baku produced 3 500 000 barrels in 30 days or 117 000 barrels daily At that period some thousands of wells in the United States were collectively yielding 150 000 barrels daily little more than the product of one well in Russia In the same year one plot of 27 acres in the Baku district operated by an English company gave 7 750 500 barrels of oil from 11 wells

From the early Baku wells oil was ejected with such impetuosity and was accompanied by so much sand that steel blocks 12 inches thick placed over the mouth of the well to deflect the flow were perforated in a few hours and had to be replaced The casing with which the wells were lined was often torn to shreds and eventually collapsed and hundreds of thousands of tons of sand which accumulated in the vicinity necessitated the services of large bodies of workmen to direct the rivers of oil to surface depressions where it would be temporarily stored

Instead of these great wells rapidly exhausting the surrounding territory as might have been expected they apparently caused the opposite effect by producing areas of low density through the removal of so much sand into which the oil from far around readily infiltrated Increased impregnation was also aided by the excessive vibration the earth sustained in the vicinity during these violent eruptions the equivalent result of torpedoing in hard rock being a consequence For miles round the roar of the escaping gas and oil could be heard and for a wide radius the earth quivered as masses of sand forced into the casing alternately and momentarily checked the flow and were expelled

The only oil wells which have approached in violence and productivity those of Russia have been occasional strikes in Borneo and Mexico A great well near Tampico Mexico yielded it is estimated in 1908 no less than 3 000 000 barrels in two months The eruption was so violent that the earth was shattered for a wide radius around and eventually a great seething crater with an area of 25 acres was formed into which the derrick and machinery disappeared The well eventually turned to water and great streams of sulphur water have since flowed from the crater It is said that 2 000 000 tons of solid matter was ejected from the well

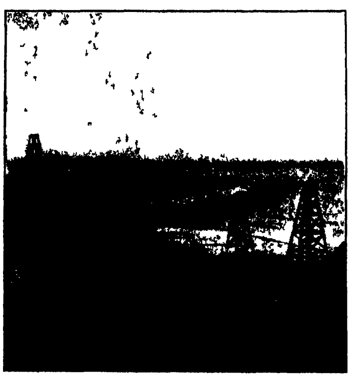
In Texas and California great gushing wells have been struck which have yielded for a while 10 000 to 20 000 and even up to 60 000 barrels a day but usually control has been less difficult on account of the smaller proportion of sand commingled with the oil

The dangers attending such ejections of inflammable material may be surmised even when the most elaborate precautions for safety are taken For weeks great wells which have accidentally ignited in Russia have burnt and consumed from 7 000 to 100 000 barrels of oil daily producing a conflagration which has illuminated an area of many square miles at night The great heat and fierceness of projection have prevented any attempts at extinction until the pressure decreased or the well became partly plugged with sand

Many such conflagrations have been the result of a spark through ejected stones striking ironwork in the derrick but often the destruction of the derrick at the first eruption has caused the electric wires to break and so a spark which led to an instant explosion

In one case where a great gusher had been burning for some weeks water entered the well and mixed with

AN ILLINOIS OIL WELL



OIL WELLS ON THE COAST

the expelled oil The great heat vaporized the water in its ascent in the flame causing periodical explosions at a great altitude which ejected unconsumed oil into the atmosphere where winds carried it for many miles over the country deluging property Where wells of less violence became ignited their extinction is frequently accomplished by projecting into the flame great volumes of some non combustible such as steam or carbon dioxide Steam has been most successfully employed by directing a large number of high pressure steam jets instantly on to the flame the rapidly expanding steam preventing access of the necessary amount of air to sustain combustion

At other times the ground has been tunneled and the casing squeezed flat by hydraulic power

When wells flow naturally under reasonable pressure and the oil is not accompanied by much sand the output is controlled by valves and the product led off as required In some fields the closing of flowing wells has led to disastrous results as on reopening no oil has been found or water has been admitted to the well This occasional result is probably due to the high closed pressure which has either so closely compacted the channels through which the oil entered the well that its reentry was impossible or to the gas forcing an outlet behind the casing into water bearing strata It is generally preferable to control the output but not entirely to check the discharge of a flowing well

After a period of natural flowing the length of which is always uncertain the oil has to be raised from the wells by artificial means The most common plan is to pump the oil by means of a cylindrical pump lowered on tubing to near the base of the well, the pump plunger being operated by rods which are given a reciprocating motion at the surface

In the design of pumps to suit local conditions and in the mechanical arrangements of operating the pumps and providing power, endless openings for individuality exist and engineers may find many opportunities for a display of originality and skill

Local conditions must determine whether gas oil steam engines or electric motors are best adapted as a source of power and local circumstances must decide whether the wells shall be pumped singly by separate motors or in groups by central stations from which the power is transmitted by tensional rods called "jerker lines

In special cases of danger compressed air has been used as power and in numerous instances where high pressure gas has been struck the gas has been led direct to steam engines and power obtained in this way Under such circumstances the cooling effect of the expanding gas causes so low a temperature that even in the tropics the engines become coated with a mass of ice as the moisture condenses and freezes around the cylinders

For the supply of power to the Baku and Roumanian oil fields fin modern electric generating stations have been erected In the Baku stations nearly 20 000 horse power is generated by three phase alternators for a tension of 2 000 and 6 000 volts Both steam turbines and vertical reciprocating steam engines are used and for the long distance transmission the voltage is transformed to 20,000 volts. The cost of electrical power is based on the price of oil

In the Russian and a few other oil fields so much sand is mingled with the oil that pumps cannot be used to any considerable extent and the oil is raised by bailing Bailers are cylindrical vessels from 10 to 40 feet in length and 6 inches to 14 inches in diameter They are fitted with a valve at their lower extremity opening inward and they are lowered and raised on wire ropes by means of a winding drum driven by a motor The speed of bailing is often over 1 000 feet per minute and the quantity of liquid raised frequently exceeds 2 000 barrels a day

Another interesting process of raising oil which is sometimes used where both sand and water accompany the oil is the air lift Air is usually led down the well between two tubes often 2½ inch and 4-inch, the outer of which extends to the base of the well, whereas the inner only reaches to within about 100 feet of the base Air enters the 2½ inch tube at its lower extremity mixes with the liquid which it aerates sufficiently to cause it to flow at the surface With a submergence of the air inlet equal to at least twice the direct lift from the surface of liquid to the surface about 1 volume of liquid can be raised to 11 volumes of free air but with a depressed level the efficiency falls greatly

The actual output and ratio of air to liquid is naturally to some extent dependent upon the density of oil the proportion of oil water and sand as well as the quantity of gas but below 50 per cent submergence the efficiency becomes very low

A NEW AGRICULTURAL INVESTIGATION.

ISOLATING HARMFUL ORGANIC SUBSTANCES IN THE SOIL.

The isolation of harmful organic substances from soil is discussed in a bulletin issued by the Bureau of Soils of the Department of Agriculture by Oswald Schreiner and Howard S Reed Previous investigations of this subject have indicated that soils may be infertile or exhausted because of the presence in them of organic compounds injurious to plants

The paper deals with the isolation and identification of some of the inhibitory or injurious compounds in such infertile soils It is almost self evident that where such bodies give rise to infertile soils there can be intelligent scientific treatment of such soils only when the nature and properties of these bodies are known The isolation and identification of these bodies is the first step in the attainment of this knowledge

In approaching this problem which is an exceedingly complex one it was found necessary to review briefly the knowledge of the origin of the organic matter in the soil This review shows that the soil organic matter arises through the decay of organic compounds of vegetable and animal origin that among these compounds are many of well known composition and constitution which get into the soil and may even persist for a time and that many compounds which are formed from these in the process of decay are likewise well established as definite chemical compounds

When the effect of these compounds which are known to get into the soil or to be formed in the soil is considered it is found that many of them have been shown to be harmful to plants some even when in very small amounts On the other hand it is not yet possible to trace any general relation between the harmful properties and the chemical composition or constitution and consequently it is not possible to determine the effect of any compound on plants except by experiment

In addition to known products of vegetable and animal origin and their products of decay it is possible that still other compounds are produced and exist in the soil about which there is no knowledge not even of a speculative kind In view of these facts it was found necessary to consider briefly the present knowledge of soil organic matter in general It was found that although the organic matter in soils is an important ingredient amounting in most cases to many tons per acre almost nothing is known of the chemical nature of this material

The difficulties then in attempting to isolate harmful organic compounds from infertile soils are due to ignorance of what compounds are harmful to plants and what are not and also to lack of knowledge of the chemical nature of the organic matter of the soil and consequent lack of methods for dealing with such material

The first crystalline organic compound isolated from a soil was a nitrogenous body picoline carboxylic acid which was obtained by a process which had its starting point in a solution of a portion of the organic matter in sodium hydrate solution This body is a definite crystalline compound with very faint acid properties and has also the power of acting as a base toward strong acids Along with the isolation of this compound there were obtained indications of the presence in the same soil of other bodies some of which are related to it

From the same and another soil by a modification of the same method another organic compound was obtained This compound dihydroxystearic acid is non nitrogenous and is in no way related to the nitrogenous body first isolated Dihydroxystearic acid like picoline carboxylic acid is a well-defined crystalline chemical compound heretofore known only as a laboratory product.

The properties of these two organic compounds were tested by the effect of their solutions on wheat seedlings Picoline carboxylic acid was found to be harmful in concentrations of 100 parts per million, and like many poisons had a stimulating effect when present in small quantities Dihydroxystearic acid was injurious [illegible] tested and ultimately caused [illegible] in concentrations of 100 parts [illegible]

Two [illegible] compounds previously [illegible] isolated from a soil. One [illegible] agroceric acid is a m[illegible] other, which has been na[illegible] cholesterol group of bo[illegible] appears to be ha[illegible] in the study of so[illegible] to their possible con[illegible] destruction of injurious [illegible] though it is not impossible [illegible] harmful to plants othe[illegible]

A[illegible] scientific interest attached to th[illegible] any definite organic compound the work [illegible] furnishes a simple tangible proof of the presence of injurious organic compounds in soils and should lay the foundation of the rational study and remedy of unfavorable conditions in such unproductive or so-called exhausted soils

In the present bulletin there are described four organic compounds isolated from soils all well defined crystalline bodies one of which is quite injurious one slightly harmful but related to much more harmful compounds and two that are not harmful so far as the wheat seedlings used in the tests are concerned, although as pointed out above other plants may be quite differently affected by these substances

In addition to these there have been isolated a number of other well-defined bodies, likewise crystalline These various soil compounds are being studied and as far as possible their nature and properties will be determined and the results given in future publications

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THE DEATH OF PROF CANNIZARRO

Prof Cannizzaro the well known Italian chemist recently died at Rome at the age of 84 In the history of chemical philosophy his name will be remembered for the part he took in placing the atomic theory on a firm and secure basis

He was born at Palermo in 1826 and educated at the Normal School and University of his native place Having devoted himself to the study of physiological chemistry he was in 1847 appointed assistant to Rafaelle Piria then Professor of Chemistry at Pisa Two years later he returned to Sicily and took part in the revolutionary outbreak in 1848 He served as an officer of artillery with the insurgents and on their defeat he fled to France, finally making his way to Paris Here he obtained a bench in Chevreul s laboratory and working with F S Cloëz discovered the compound cyanamide, in 1851 In this year he was appointed Professor of Physical Chemistry at the National College of Alessandria, in Piedmont, and during his tenure of this office he prepared benzyl alcohol by treating oil of bitter almonds with alcoholic potash—a reaction now known by his name In 1855 he became Professor of Chemistry at Genoa and in 1861 he went to Palermo in the same capacity In 1871 he was appointed Professor of Chemistry and Director of the Chemical Institute at Rome while at the same time in view of his scientific distinction, he was elected to the Senate, of which he became Vice-President

In the middle of last century there was great uncertainty as to the criteria for determining the atomic weights of the elements, and this was reflected in the confusion which surrounded the formulæ used by different chemists to express the composition of compounds. In his "Sunto di un Corso di Filosofia Chimica,' which was published in 1858 and ranks as one of the classics of chemical literature, Cannizzaro pointed out that the incongruities disappeared and order was introduced if the distinction between atoms and molecules were properly observed, and he showed how it was possible to ascertain the atomic weights and their relations to the molecular weights by the aid of the specific heats of the elements, and of the hypothesis put forward by his countryman, Avogadro, nearly half a century before, that under equal conditions of temperature and pressure, gases contain equal numbers of molecules. This achievement won for him, in 1891 the Copley Medal of the Royal Society, of which he was chosen a foreign member in 1889, and a still earlier English recognition of the value of his work, was his selection, in 1862, as a foreign member of the Chemical Society, before which, ten years later, he delivered the Faraday lecture.

SOURED MILK.

ITS NATURE, PREPARATION, AND USES.

BY R. T. HEWLETT.

THERE seems to be little doubt that as age advances the microbial flora of the human intestine especially of the lower portion or large intestine often undergoes a change both in the number and in the character of the micro-organisms present From middle life onward the number of microbes increases and species capable of inducing putrefactive decomposition of proteins become more abundant This change can be roughly gaged by making microscopical preparations of the dejecta and staining by the Gram process, a selective method by which certain organisms only are stained In the child s dejecta Gram staining microbes are relatively scanty and are mostly *Bacillus bifidus* and *B acidophilus* and it is noteworthy that these are lactic acid producing bacilli In and after middle life Gram staining forms usually become more and more numerous the Gram staining species now being principally *Bacillus putrificus* and *B Welchii* bacteria which induce marked putrefactive decomposition of proteins[1] In unhealthy conditions of the intestinal tract somewhat similar changes or various abnormal fermentations may occur

Metchnikoff[2] in a study of the nature of senility formulated the hypothesis that it is caused partially at least by auto intoxication poisoning by the absorption of products derived from the action of micro-organisms in the digestive tract Such poisons would be the products of the putrefactive decompositions brought about by the micro-organisms named and also bodies belonging to the phenol series which are formed by the action of *Bacillus coli* which is always present in the intestines becomes more and more numerous from youth to old age and which also multiplies excessively in [illegible] conditions of the digestive tract In seeki[illegible] combat the multiplic[illegible] to inhibit [illegible]rious forms But the prob[illegible] for it entailed the finding of a lactic acid fer[illegible] which would grow at body temperature (99 deg F) and maintain itself in spite of the competition of the other micro-organisms present The ordinary lactic acid ferments found in milk grow best at 7[illegible] to 85 deg F and are unsuitable

Metchnikoff says[3] I had no illusion as to the difficulty sure to be encountered in any effort to introduce lactic microbes into the intestinal flora which has been preoccupied by a multitude of other microbes To make surer of the result I chose the lactic microbe which is the strongest as an acid producer It is found in the *Yoghurt* which originates in Bulgaria The same bacillus has also been isolated from the *leben* of Egypt and it is now proved that it is found in the curdled milk of the whole Balkan peninsula and even in the Don region of Russia Metchnikoff also noted that some of these who consumed a diet of little else than the soured milk lived to an advanced age This then was the origin of the use of Bulgarian sour milk and of the introduction of artificial substitutes for the natural article It may be added that the use of sour milk seems to be widespread in the East, for it is found also in Turkey, Siberia and Asia Minor and in India under the name of "Dadhi"[4] As Chaterjee says "The extensive use of one or other varieties of fermented milk produced by means of a special ferment in Eastern countries, probably owes its origin to the difficulty of preserving milk in a sweet condition for a long time in comparison to cold countries, milk when undergoing spontaneous decomposition in hot climates becomes changed within a few hours to a foul-smelling fluid in which the casein and the fat have undergone liquefaction whereas when fermented by means of the special ferment the decomposing gas-producing proteolytic bacilli are killed off by the more vigorous organism of the ferment, which has no destructive action on the fatty or albuminous constituents of milk so that by this means milk can be kept in a condition fit for consumption for a long time '

The bacteriology of the various natural sour milks is somewhat complex and not yet fully elucidated although considerable research has been devoted to it Micro-organisms of a peculiar type are present in all One of the first to be isolated was the *Bacillus bulgaricus* a large Gram staining non sporing rod shaped organism which grows best at temperatures between 110 deg F and 120 deg F Development however is slow even at the optimum temperature taking three days for the maximum production of lactic acid in milk and it is therefore unsuited for the preparation of artificial soured milk Another organism is the granule bacillus (Körnchenbacillus) of Kuntze This is probably the organism so often spoken of as the bacillus of Massol and is widely used for the preparation of soured milk as it grows rapidly and well at a temperature of about 100 deg F and produces a relatively high percentage of lactic acid The name of granule bacillus is derived from the fact that granules which stain deeply are present in the bacterial cell In all the natural soured milks somewhat similar micro organisms are to be found It is of interest that Kuntze has suggested that these Bulgarian lactic ferments are allied to the *B acidophilus* and *B bifidus* which as already stated are present in the child s intestine and they are probably primarily of intestinal origin

In natural sour milks the special lactic acid ferments are always associated with other ordinary lactic acid bacteria particularly a Streptococcus (*S lacticus*) and a mixed culture of this last named organism with the bacillus of Massol presents advantages over the use of the latter alone[5] For instance when the *B bulgaricus* grows alone in milk it has some effect on the fat producing small quantities of nauseous tasting substances but Metchnikoff has shown that this result is entirely obviated by a symbiotic growth with an ordinary lactic acid organism The ingestion of milk soured by an ordinary lactic acid organism also tends to produce in the intestine an acid environment which favors the growth and persistence of the special lactic ferment, the bacillus of Massol

Various procedures are adopted for the preparation of the natural sour milks According to one account Yoghurt is prepared by boiling milk until it has diminished to half its volume by evaporation it is then allowed to cool somewhat and a little of a previously prepared sour milk is added and the whole allowed to stand in a warm place until next day Another method is to wipe round a wooden bowl with a piece of cheese (presumably prepared with the sour milk) and then to introduce into the bowl the boiled milk Dadhi is prepared by boiling milk for some time cooling to blood heat and then inoculating with a needle dipped in a former brew The inoculated milk is covered with a blanket and kept in a warm place for 12 hours

For the artificial production of soured milks the milk is well boiled in order to sterilize it and destroy undesirable organisms and when it has cooled sufficiently a starter consisting of a pure culture of the proper lactic ferments is added The inoculated milk is then kept at 100 deg F or thereabout for from 10 to 24 hours according to the amount of starter added and should then be fit for use Many starters both liquid and solid (tablets) are to be had but only a few are to be recommended as some are grossly contaminated with undesirable bacteria Another method is to add a little of the previous day s preparation to the milk to be soured Some of the large dairy companies also supply the soured milk ready for consumption

Considerable care must be exercised in preparation to use sterilized vessels and to safeguard the milk from contamination during incubation The milk properly prepared should be thoroughly curdled possess a not unpleasant tart flavor, and have a marked acid reaction Some of the older starters contained sporing bacilli which though they curdled the milk (owing to tryptic ferments) gave rise to little or no acidity Preparations containing a combination of the bacillus of Massol with *Streptococcus lacticus* or *lebenis* are probably the most suitable

The internal administration of tablets etc containing the lactic ferments in place of the soured milk is of questionable utility

Although some are still skeptical as to the value of soured milk it can hardly be doubted that it is beneficial in many complaints[6] Among these are (*a*) those depending on abnormal putrefaction of proteins in the intestinal tract and including certain cases of acute enteritis and acute and chronic colitis (*b*) auto intoxication with products of intestinal putrefaction as in many cases of general failure of health in elderly persons forms of anæmia neurasthenia with flatulent dyspepsia etc In minor ailments such as lassitude headache some forms of constipation and diarrhœa rheumatic pains and the like benefit frequently results It must also be recognized that even if the soured milk as such does little good it often enables an addition of valuable and easily assimilable food stuff to be made to the diet by its use On the other hand soured milk is by no means a universal remedy and should not be taken indiscriminately without medical advice as it sometimes disagrees

Moreover the home preparation of soured milk cannot be recommended unless it is undertaken by a member of the household having some knowledge of the scientific principles involved in the practice of sterilization and use of pure cultures —Nature

THE NUMBER OF ANIMAL SPECIES

THE well known zoologist A F Shipley in a paper read before the British Association for the Advancement of Science gives interesting statistics concerning the numbers of known species of animals of all classes About ten years ago Gunther made a careful comparison of the numbers of species of the various groups of animals that were known in 1830 or thereabout with the numbers known in 1881 During the intervening half century the known species of mammals increased in number from 1 200 to 2 300 birds from 3 600 to 11 000 reptiles from 43 to 3 400 fishes from 3 [illegible]00 to 11 000 mollusks from 11 000 to 33 000 moss animalcules from 40 to 1[illegible]0 crustacea from 1 290 to 7 [illegible]00 arachnida (spiders etc) from 1 048 to 8 070 myriapods (centipedes etc) from 4 0 to 1 300 insects from 19 100 to 220 1 0 echinodermata (sea urchins starfishes etc) from 230 to 18 043 worms from [illegible] to [illegible] 070 cœlenterata from [illegible]00 to 2 200 foraminifera from 50 to 400 and protozoa from 30 to 3 00 The total number of animal species of all kinds known in 1840 was 73 588 in 1881 the number had increased to 311 653 The average number of new species discovered each year since 1881 may fairly be estimated at about 12 000 so that the total number of species now known must exceed 600 000 But the number of species yet unknown is probably very much greater than this In 189[illegible] Sharpe estimated the number of known species of insects at a quarter of a million and expressed the conviction that ten times as many insect species yet awaited discovery Insects and small animals in general offer an almost unlimited field for exploration while in the case of large animals and especially of mammals it is probable that a majority of living species is already known

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In a paper read some little time ago before the American Institute of Electrical Engineers Mr P M Lincoln elaborated a hydraulic analogy to a three phase line which will be useful in enabling electrical engineers to form a conception of the phenomena of electric surges He concludes that electrical transmission lines can be guarded against the dangers arising from electrical surges by using some or all of the following precautions By means of an overhead guard wire the quantity of electricity which a given lightning discharge is capable of superposing upon a transmission line is kept down In practice it has proved of value in many cases of high tension transmission The use of efficient lightning protectors is absolutely essential By earthing the neutral solidly the potential of the line is prevented from attaining dangerous values It is also very essential to insulate the windings of electrical apparatus so that they can withstand a momentary potential many times greater than the normal

---

[1] Herter, "Bacterial Infections of the Digestive Tract," [illegible] v

[2] "On the Prolongation of [illegible] Life."

[3] Century Magazine, November, [illegible], p. [illegible].

[4] Chaterjee, Ind. Med. Gazette, [illegible], [illegible], p. [illegible].

[5] "On the Bacteriology of Yoghurt, etc see Tuersen and Kühn Centralbl. f Bakt Abt ii xx 1908, p 284 Kuntze ib xxi 1908, p 737, White and Avery ib xxv 1909 p 161 Hastings and Hammer ib xxv., 1909, p 419 Full references to the literature of the subject are given in these papers.

[6] Herschel, Proc. Roy Soc Med., January, 1910.

THE USE OF ANESTHETICS FOR PLANTS.*

ARTIFICIAL ACCELERATION OF GROWTH.

BY S. LEONARD BASTIN.

Nowadays the gardener has to adopt all kinds of ingenious devices in order to obtain the flowers for which there is such an unceasing demand. One of the most interesting of those methods which have been recently introduced is the system of the anesthetization of plants in order that they may come the more quickly to perfection. Some years ago Dr. Johannsen of Copenhagen carried out a number of elaborate inquiries in order to find out the effect of chloroform and ether upon vegetable tissue. After a long series of experiments he was able to show that certain plants when submitted to the influence of the vapors of these drugs while in a dormant condition behaved in a curious way afterward. It seemed that the anesthetic intensified their restfulness and brought about a remarkable activity when ordinary growth was allowed to be resumed. Moreover it was noted that the all round excellence of the plants so treated was greater than in the case of specimens which were in a normal condition.

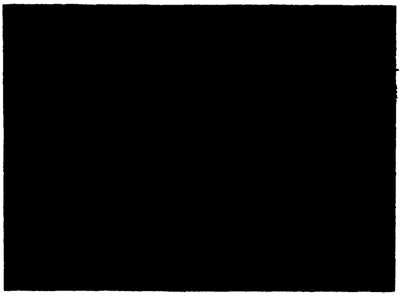
It soon became evident that a discovery of real commercial value had been brought to light. The production of flowers is such a serious business nowadays that anything which will save the grower time is a matter of great importance. Further experiments went a long way to indicate the lines on which the treatment would be likely to be most successful. It was found that lilacs, azaleas and especially lilies of the valley were plants which were amenable to the ordeal. As well, many sorts of bulbous species seem to repay for the trouble by an accelerated growth and an enhanced beauty of development. Of course the expense involved in the system is so trivial as scarcely to be taken into consideration.

The mode of procedure is on the following lines. When the plants or roots are in a perfectly restful condition they are taken in hand for treatment. A perfectly airtight box or tin case is obtained and all the specimens are stored away in the bottom of the receptacle. From the inside of the lid of the case is suspended a smaller vessel and it is into this that the spirit is poured. It is necessary that the temperature throughout the proceedings should not fall below 62 deg. F. As soon as the chloroform or ether is placed in the vessel the lid of the case must be closed down and is not again to be opened. Of course the vapor from the drug being heavier than air sinks to the bottom of the box and mingles among the roots and plants lying there. For a period of forty-eight hours the case is left, at the end of which time all the specimens are removed, planted and grown in the ordinary manner. No very great degree of heat appears to be desirable beyond that available in a well warmed glasshouse.

At first the anesthetized plants are only exposed to the light to a small extent. It is very soon, however, that the advantage of the new treatment becomes apparent when the specimens are compared with those which have been grown normally. A few days elapse and the plants seem literally to jump into life: the buds burst open, the leaves begin to expand and in a short while the flowers put in an appearance. The actual saving of time brought about by the adoption of this method is very considerable. Lilies of the valley treated with ether were in full bloom in a fortnight from the start. Some azaleas which were potted up after exposure to the anesthetic were out on March 8, although they had only been growing from the 25th of February. Specimens which had not been treated at all and were started at the time of the others did not come to maturity until at least a fortnight later. In the case of [illegible] the saving of time was equally [illegible]isfactory.

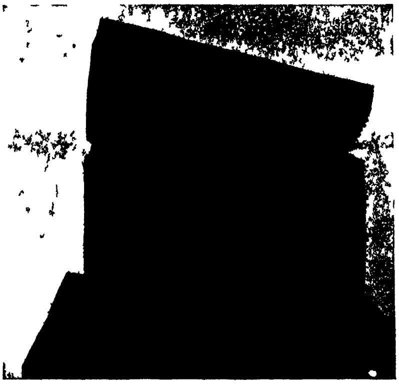
The [illegible] succeed best under a [illegible] of no little [illegible]. Thus it is fo[illegible] the re qu[illegible] the case of a[illegible] take the ma[illegible] investi gat[illegible]thetic. The[illegible] when the [illegible]ount of ca[illegible]ther is ne[illegible] these are v[illegible]

In [illegible] at the pre[illegible]ry. The new [illegible]ality which [illegible] of this plant in the early [illegible] year—that is, the matter of leafage. Lilac could be induced to develop its blooms with heat, but the plants would not develop their foliage. After the specimens have been anesthetized the leaves are produced in the greatest profusion at the same time as the flowers. A similar result is to be noticed to a large extent in the case of lilies of the valley. On the whole this method offers many interesting opportunities of study that may be turned to account.



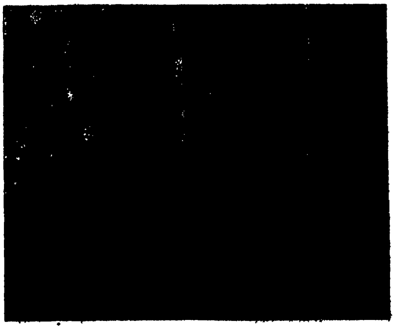
LILY OF THE VALLEY READY FOR ANESTHETIZATION

YOUNG WELL-BUDDED LILAC WITH ROOTS WRAPPED READY FOR ANESTHETIZATION



AIRTIGHT BOX FOR ANESTHETIZATION OF PLANTS

The chloroform or ether is placed in the receptacle at the top and the heavy vapor sinks to the bottom.



THE ANESTHETIZATION OF LILIES OF THE VALLEY.

Note difference between plants in foreground and those at back.

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* From American Homes and Gardens. Published by Munn & Co., Inc.

SQUIBS, FUSES, AND DETONATORS.*

HINTS FOR THE MINER.

BY C. E. MUNROE AND CLARENCE HALL.

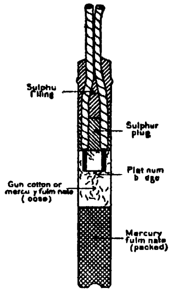
An explosive is a compound which can be caused to explode by various means All explosives can under some circumstances be made to explode by fire Some of them can be caused to undergo a detonating explosion by setting off a detonator in contact with them. In blasting use is made of both these means for setting off explosives the means used being determined by circumstances.

In setting off by means of fire, use is made of miners squibs or of fuse Miners squibs consist of tapering paper tubes about 7 inches long filled with fine gunpowder one end of each paper tube being treated with chemicals so as to form a slow burning match which when ignited, burns so slowly as to give the miner time to reach a place of safety before the explosion When used the squib is placed in the needle hole or blasting barrel through the tamping with the match end of the squib outward When the match is ignited the fire burns slowly along the tube until it reaches the powder core Then the squib darts forward like a rocket leaving a trail of flame behind which spurts out from the needle hole and the fire continues burning along the powder core of the squib until it bursts out of the other end of the tube and so ignites the charge

In experiments made at the Pittsburg testing station it has been found that, though the burning match on the end of the tube of the squib does not inflame a mixture of mine gas and air as soon as the powder core is ignited the flame that then flashes out from the end of the squib will explode the mixture Hence squibs should not be used in any gaseous mine

Fuse as used in coal mines is sent out into the market in coils 50 feet long and in several varieties but all consist of a core of mealed gunpowder inclosed in two or more layers of yarn and generally surrounded by tape that has been dipped in a waterproofing composition Some varieties are then dusted with substances like [illegible] soapstone to prevent the sticky surfaces from [illegible] another The kinds of fuse most used are hemp fuse, cotton fuse, single-tape fuse, double-tape fuse, triple-tape fuse

When one end of a fuse of any variety is lighted the powder core burns slowly along the fuse till at last the flame rushes out at the farther end and, if it touches a charge of powder, sets it off Like squibs, fuse throws off flames when lighted, and hence the use of fuse in a gaseous mine cannot be recommended Fuse should be so made and should be in such a condition when used that any part of any coil will burn at the rate of a foot in eighteen to twenty seconds This is of the greatest importance because in setting a charge the blaster or shot firer cuts a piece of fuse to reach from the charge to the opening and long enough to give him ample time after the end has been set on fire to reach a place of safety before the flame fires the charge Therefore careful tests should be made of the rate of burning of pieces of the fuse whenever there is any doubt whatever as to its soundness Although the manufacturers may produce a fuse with a regular rate of burning the rate may be changed by bad handling as for instance by squeezing the fuse so as to disturb the powder core or by suddenly and roughly opening the coil when it is stiff from cold, so as to crack the fuse; or the fuse may be injured by rubbing against the rough surfaces of the rock. In cutting the fuse and in fitting it into place, care must be taken that the powder core does not run out from the fuse for that might cause a misfire.


Sulphur filling
Sulphur plug
Platinum bridge
Gun cotton or mercury fulminate (loose)
Mercury fulminate (packed)

ELECTRIC DETONATOR SHOWING ITS COMPONENT PARTS

Detonators (which are also called blasting caps and sometimes are called exploders, though the last term applies to any means of producing an explosion and therefore is not commended here) consist of copper capsules about as thick as an ordinary lead pencil which are commonly charged with dry mercury fulminate or with a mixture of dry mercury fulminate and potassium chlorate that is compressed in the bottom of the capsule filling it to about one third of its length

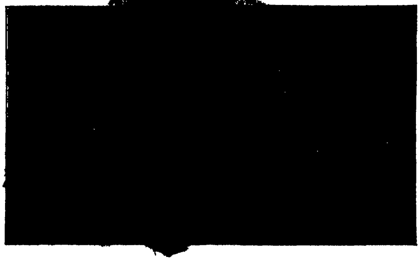
Dynamite and other detonating explosives are in practice fired by means of detonators for though they may be exploded by the aid of squibs or fuse or by means of gunpowder primers yet the explosion so produced is not a complete one the explosives are not used to their best advantage all of the work that they can do is not done and moreover the gases that are produced are usually dangerous Where high explosives are employed it is safer to fire with detonators strong enough to cause their most complete explosion Permissible explosives should be fired by detonators and are best fired by electric detonators of the strength prescribed for each one

Detonators are fired by the aid of a piece of fuse The end of the fuse is inserted in the mouth of the blasting cap and carefully pushed down until it gently touches the surface of the detonating composition and then the cap is crimped onto the fuse The cap with the attached fuse is inserted in the charge to be fired which when placed in the bore hole and tamped is ready for firing The end of the fuse is lighted and the fire burns down the powder core until it streams against the detonating composition which then detonates and causes the detonation of the explosive with which it is in contact

It has been found at the Pittsburg testing station that the flame which rushes out from a fuse when it is ignited at the mouth of a bore hole will ignite an explosive mixture of mine gas and air Therefore fuse should not be used either alone or with detonators in fiery mines

The practice of fitting the fuse to the detonator is common in quarries tunnels and mines that are not gaseous Accordingly it is customary to make both detonators and fuses in standard sizes so that the fuse may easily slip down within the mouth of the detonator and yet make a neat fit within it

By the use of electric detonators (also called electric fuses) the dangers that are common in the use of squibs or fuse in gaseous coal mines are avoided These electric detonators are simply ordinary detonators that have been fitted with a means of firing them by the electric current This is done by inserting within them two copper wires joined at the inner



MINERS SQUIB.

MINERS SQUIB AND FUSE

CRIMPING DETONATOR ON FUSE

DETONATORS AND ELECTRIC DETONATORS

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* Abstracted from Bulletin [illegible] of United States Geological Survey.

ends by an extremely fine platinum or other high resistance wire which like the carbon filament in the ordinary incandescent lamp becomes heated till it glows when an electric current is passed through it This wire known as the bridge is placed above the detonating composition and is surrounded by gun cotton or loose fulminate The space above it and the mouth of the capsule are then filled and closed by means of a plug of sulphur or other waterproof composition which is poured in while soft The copper wires pass through the plug and are long enough to extend outside the capsule These outer ends are called the legs or wires of the electric detonator Although the copper wires are bare within the electric detonator the legs outside are covered with an insulating wrapping These legs are made of different lengths in order to suit different depths of bore holes The charge of detonating composition differs in the different grades of electric detonators so as to give different strengths

In loading bore holes electric detonators are placed in the charge just as detonators with fuse are and the bore holes are tamped in a similar manner To fire the charge the legs of the detonator are connected by leading wires to an electric device at a safe distance and from it the current is sent to fire the blast No flame can escape from the bore hole during the firing for the tamping fills the hole completely and hence blasting in gaseous mines is made much safer

Only electric detonators are used at the Pittsburg testing station in the tests of explosives for use in mines

What are called delay action electric exploders or detonators are now being offered for use where a number of holes are to be fired at once but so that the charges may explode one after another This is done by placing a piece of fuse or other device in the electric detonator between the detonating composition and the bridge and inclosing the whole so that the flame may not escape from the blast hole In the present state of knowledge this practice is not commended for use in coal mines

Never attempt to pick out any of the composition Do not drop them or strike them violently against any hard body Do not lay them on the ground where they may be stepped on Do not step on them In crimping take the greatest care not to squeeze the composition and never crimp with the teeth for there is enough composition in one of these small capsules to blow a man's head open They should be stored in a dry place and in a building apart from any other explosives They should never be carried into a mine with other explosives and they should never be placed in a mine near other explosives except in bore holes When carried or shipped they should be packed firmly with a quantity of elastic material such as felt or the coiled legs of the electric detonators about them and they should not be exposed to heat blows or shocks of any kind

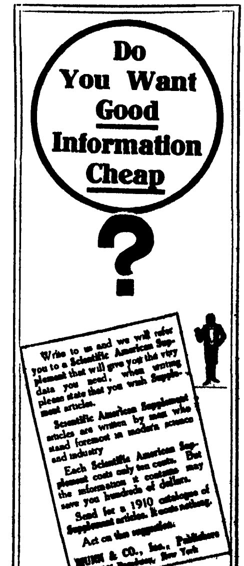
In a recent number of Power Mr H B Taylor gives a detailed description of four 18 000 horse power reaction turbines of the vertical shaft single runner inward flow Francis type operated under a [illegible] foot head at 400 R P M with an efficiency of 83 per cent The turbines are for the Great Western Power Company's station on the Feather River Oroville California. It is only within the last few years that the reaction type of turbine has been used for heads of over 300 feet the impulse or Pelton wheel having hitherto been used almost exclusively for such heads The turbines and governing apparatus were made by the I P Morris Co of Philadelphia The runner of special bronze runs in a cast steel volute casing and the water is delivered to the runner through cast steel movable guide vanes spaced round the periphery of the runner The governor situated near the alternator controls the guide vanes by oil pressure and the piping is made large so that the inertia of the oil may be overcome in a very small increment of time The whole operating mechanism is so sensitive that the guide vanes begin to move before the speed of the turbine has varied more than ½ per cent from the normal The normal pressure of the water in the wheel casing is 220 pounds per square inch and the steel casing was tested to 400 pounds The weight of the runner vertical shaft and the rotating field system of the 10 000 kilowatt alternator is 14 000 pounds and this is carried by an oil thrust bearing The bearing consists of an upper and lower disk the former connected to the shaft Between the disks there is an annular chamber into which oil is pumped at a pressure of [illegible]0 pounds per square inch The oil is cooled by water piping In the efficiency tests the volume of the water delivered to each turbine under various conditions of load was determined by taking traverses with Pitot tubes in the penstock The Pitot tubes were carefully calibrated by checking against a weir at Niagara Falls The pressure head was determined by taking the average of the readings of eight piezometer tubes connected to eight equidistant points on the circumference of the penstock The efficiencies under a 420 foot head and 14 000 horse power were as follows No 1 87 per cent at 87 per cent load, No 2 87 per cent at 90 per cent load No 3 88 2 per cent at 93 per cent load, No 4 89 per cent at 91 5 per cent load

SCIENCE NOTES

Applied science has already made some contributions to American education and civilization and so far as its use in the schoolroom is concerned applied science as an educative agency is not exceeded in value by any other instrumentality Its very general acceptance by teachers and students in our leading educational institutions does not prove its value but does prove that its value is being appreciated

A new lecture experiment on the pressure of light has been devised by A Amerio He uses a cylinder about 3 centimeters in diameter and 1 centimeter high made from a sheet of thin Al blackened with Indian ink and covered with a thin layer of transparent varnish the silk fiber by which the cylinder is suspended lies in the prolongation of the axis The support of the absorbent material being a good conductor of heat causes a diminution of the radiometric effect owing to the small difference of temperature between its two faces the distribution of the energy of the incident beam may be asymmetric without causing inconvenience since all the radiometric actions converge toward the center and lastly the thin layer of varnish removes the objection that the radiometric effect destroys the light pressure effect

On his second invasion of Britain in B C [illegible] Julius Cæsar sailed up Southampton Water and after a sturdy resistance by the Britons took and destroyed Trisanton but beyond that Cæsar seemed to have done little by his second invasion save to extract at the point of the sword a promise from the Britons to recognize the power of Rome by an annual payment and upon this he withdrew To avoid a repetition of this attack the Britons re established their capital twelve miles farther up the river Itchen near the ancient oppidum known as Cær Gwent now St Catherine's Hill Here in the valley of the Itchen they built their new capital which they called Camelot and erected a royal palace where stand the ruins of Wallesey or Wolvesley Palace at Winchester To protect the mouth of the Itchen they constructed a great defensive work at Woolston considerable traces of which are still quite evident and where within the last few years remarkable discoveries of bronze implements and Celtic coins have been made This camp was referred to in the account of the invasion of Aulus Plautius in the year 43 A D as Cær Peris or Byris or B[illegible]e which was corrupted today into Pear Tree Green The Roman station of Clausentum later became the seat of the Roman power in this district and it remained a city till the end of the Saxon period Winchester continued to be the Celtic capital till the more thorough and effective invasion of Vespasian took place which broke up the Celtic form of government and established that of Rome —The Architect and Contract Reporter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TRADE NOTES AND FORMULÆ.

Volatile Copal Varnish.—*a* Copal, 60 parts, ether, 10 parts, alcohol 60 parts oil of turpentine, 40 parts. *b* Copal 10 parts acetone 30 parts alcohol 30 parts. Distill at 133 deg F whereby the acetone, which proves very serviceable as a solvent of the copal will be nearly all recovered, the copal remaining in solution in the alcohol

A Dull Copper Bronze (J Rhein) – Rub umber graphite and a quantity of copper bronze to a brown paint with siccative and coat the object with it completely using a fine bristle brush Shade the raised portions immediately with copper bronze, and glaze, when dry with spirit lacquer The bronze will be somewhat lighter in tone if it is dried after the first coat of brown then coated with copal lacquer containing little oil and bronzed dried and glazed as previously directed In rubbing up the brown color, it is well to add a few drops of turpentine oil from time to time as the siccative dries very rapidly

Fine Copper Bronze (J Rhein) —Coat the object with copal lacquer and bronze with a mixture of a quantity of copper bronze with some graphite and umber When dry coat with dilute brown spirit lacquer touch the raised portions with a copal lacquer containing but little oil using a bristle brush then bronze again with copper bronze The bronze dust which falls into the hollows and crevices must be removed with a clean hair brush and the purpose of the spirit lacquer is to make this possible Finally glaze with brown or reddish brown spirit lacquer All bronzings unless directions are given to the contrary should be allowed to dry slowly

Colored Copying Pencils – Red Dissolve 65 parts of ponceau red in 200 parts of shellac soap solution by heating and add 2 parts powdered tragacanth 4 parts of albumine dissolved in 12 parts of water Stir into this colored paste 130 parts of cinnabar (vermilion) mass and constantly stirring evaporate it in a water bath at a temperature of 50 deg R (144 deg F) until it is of such consistency as to be capable of being pressed into sticks. (Shellac soap solution is made as follows [illegible] soap is dissolved in 60 parts of wat[illegible] [illegible]ts of shellac dissolved by boili[illegible] [illegible]ed by saponification of [illegible] [illegible]s of palm oil, with ca[illegible] [illegible] parts of the finest cinn[illegible] [illegible] dried and pulveri[illegible] [illegible] aniline blue solu[illegible] [illegible] water and boil[illegible] 1 part of powder[illegible] [illegible] mass in finest[illegible] must be expos[illegible] [illegible]ul phate of [illegible] brushing o[illegible] treatment [illegible] is then moist[illegible] sugar have be[illegible] [illegible]mine dissolved [illegible] [illegible]bbed through a fine [illegible] mass ½ part of indigo ca[illegible] the desired consistency in a w[illegible] at [illegible] F (Milori blue mass consists of 1 part milor[illegible] blue and 6 parts of the finest washed kaolin both substances ground absolutely fine in a wet mill dried and pulverized adding before grinding 0 5 part of English sulphuric acid) Black 11 parts ponceau red, 15 parts aniline blue soluble in water and 1 part of pulverized tragacanth together with 1 part finest albumine dissolved in 3 parts water, and then filtered, are dissolved in 60 parts of hot water and to the concentrated solution 40 parts of finely ground fat clay 8 parts indigo carmine and 3 parts of Chinese India ink added The mass must be pressed several times and the sulphate of soda removed

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